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Impact Assessment Study on Common Chargers of Portable Devices

Draft Final Report

Ipsos, Trinomics, Economisti Associati, Fraunhofer FOKUS
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Executive summary

To be added for the final report
1 Introduction

This draft final report is the third deliverable submitted to the European Commission by Ipsos, Trinomics and Fraunhofer FOKUS (on behalf of a consortium led by Economisti Associati) in the context of the Impact Assessment Study on the Common Chargers of Portable Devices.

The aim of this study is to provide input for the Commission impact assessment accompanying a new initiative to limit fragmentation of charging solutions for mobile phones and similar devices, while not hampering future technological evolution.

This report presents a draft version of all elements of the study, to be further refined, updated and, where necessary, completed following discussions with and comments from the Commission services. The submission of the final report is foreseen for mid-November 2019.

The report is structured as follows:

- Chapter 2 provides a brief overview of the methodological approach to the study.
- Chapter 3 contains a detailed discussion of the current situation regarding chargers for mobile phones, including an account of the main problems the initiative is intended to address.
- Chapter 4 describes the baseline and the concrete policy options that have been shortlisted for in-depth assessment, following a discussion of a wider range of elements that were considered.
- Chapter 5 contains the analysis of the likely social, environmental and economic impacts of the different options, as well as important considerations regarding the expected decoupling rates and other potential implementation issues.
- Chapter 6 summarises the main likely impacts of all shortlisted policy options, and compares these to provide an aid to the political decision making process this study is intended to support.
- The Annexes contain supporting materials, including synopsis reports with the main results of the Commission's public consultation and the consumer panel survey carried out by Ipsos, as well as product fiches with additional market and technological data.
2 Methodology

Our overall approach employed a mixed method, combining two main tasks. First, defining the problem (including a market and technology analysis as well as an assessment of the effectiveness of the previous MoU), and second, an assessment of the likely impacts of a set of policy options going forward.

The main tasks of the methodology were structured across three phases. The inception phase included an initial definition of the problems that exist in the current situation, and of possible policy options to address these, as discussed in detail in chapter 4. Policy options were reviewed and finalised during our data collection phase, and a comprehensive impact analysis and comparison of policy options at hand was produced during the analysis phase.

Figure 1: Overall study approach

Sources of evidence

The evidence base for this study includes both primary and secondary data. As part of this study, we consulted and collected information from a variety of stakeholders (including consumers and industry representatives). More specifically, this included:

- An online panel survey of a sample of around 5,000 consumers across ten EU Member States
- 36 in-depth interviews with representatives of all key stakeholder groups (relevant industry sectors, civil society, and public authorities); see the table below for further details.
- Where relevant, the study also drew on the results of the public consultation designed and launched by the European Commission, addressed to interested parties at large, including potentially all stakeholders as well as EU citizens.

Table 1: Overview of stakeholder interviews conducted

<table>
<thead>
<tr>
<th>Main groups</th>
<th>Sub-groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of interviews</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main groups</th>
<th>Sub-groups</th>
<th>Number of interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>Mobile phone manufacturers</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Companies in other relevant sectors</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Industry associations</td>
<td>3</td>
</tr>
<tr>
<td>Civil society</td>
<td>Consumer organisations</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Environmental NGOs / experts</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Product safety organisations</td>
<td>1</td>
</tr>
<tr>
<td>Public authorities</td>
<td>European / international organisations and standardisation bodies</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>National authorities of EU Member States</td>
<td>3</td>
</tr>
</tbody>
</table>

In addition to the fieldwork carried out, a comprehensive desk review of existing literature and market data was undertaken. This allowed us to collect information on a number of important aspects, including: the market for mobile phones and chargers; key features of mobile phone chargers, and relevant industry standards; information on other devices that might be charged with mobile phone chargers; and data on relevant economic, environmental, product safety and other considerations.

Based on the evidence collected, a stock model of mobile phone chargers was developed to assess the impacts of each policy option on the composition of the mobile phone chargers stock across the EU. This model compiled charger (phone) sales data and matched this with data and assumptions on charger disposals to simulate changes in the stock of chargers in use in the EU28. The model enabled calculation of quantitative estimates of environmental impacts and impacts on costs.

Assessment of key impacts

The study used a range of data sources and analytical techniques to estimate (where possible, quantitatively) the most significant likely impacts of the policy options under consideration. In particular:

- **Impacts on consumers**: Potential consumer impacts of different policy options developed relate to the level of inconvenience experienced by consumers when using mobile phone chargers, the frequency with which certain problems were encountered, and any costs incurred as a result. Evidence on these elements was collected through a panel survey of a sizeable, representative sample of EU consumers. A research panel is a group of previously recruited respondents who have agreed to take part in surveys and/or other research. The survey covered 10 Member States (incl. five of the largest ones – Germany, France, Italy, Poland, and Spain; as well as the Czech Republic, Hungary, the Netherlands, Romania and Sweden), and collected 500 responses per country. Survey data was weighted to produce a representative and comprehensive picture of consumer opinion and experience across the EU. Apart from questions on the type of chargers used and the nature of use, the survey also included a conjoint experiment which provided insights into the relative importance of product attributes related to interoperability and charging performance.
- **Environmental impacts**: As part of the prospective impact assessment, changes in environmental impacts across the different policy options were identified using evidence from desk review of relevant documents, such as Life Cycle Impact Assessment studies, the consumer survey, stakeholder consultations and market data. Unit level impacts of the key charger components (EPS, cable and adaptor) were estimated and then multiplied by the number and type of chargers produced and discarded per year in the EU as calculated using the stock model to estimate total impacts. The impacts considered include GHG emissions, material use and e-waste generation. The main environmental impacts of the future initiative relate to two key factors: (1) the change in composition of charger types under different policy options; (2) the decoupling of new chargers from device sales. In other words, significant benefits would materialise if chargers were interchangeable and the number of unnecessary chargers sold were to decline, which is unlikely to occur while mobile phones and other devices are routinely sold with a charger or if competing mutually incompatible devices proliferate.

- **Economic impacts**: The main potential economic impacts of the initiative relate to the additional costs of (or savings from) the new requirements for both consumers and economic operators, as well as impacts on innovation and technological development. To the extent possible, costs were estimated via the stock model, while the analysis of other impacts on economic operators relied heavily on information collected from industry representatives (incl. manufacturers of mobile phones, manufacturers of other portable electronic devices, manufacturers of chargers, and distributors). In addition to 22 in-depth interviews with industry representatives, evidence made available by industry to the study team was analysed on top of responses submitted to the public consultation and secondary data.

Based on the policy options and impact screening finalised at the interim stage of the study, the options were compared using Multi-Criteria Analysis (cost-benefit analysis was not feasible due to the fact that some key impacts could not be quantified or monetised). This combined the results from the impact analysis to enable an objective comparison of the relative costs, benefits and impacts of the options. More detail on our options assessment is provided in section 6.

**Main limitations and caveats**

Limitations to our approach stem from the assumptions made in the stock model, e.g. on production costs, charger weight and composition and future development of the mobile phone market. Whilst we have used the best available evidence, part of the assumptions underlying the stock model and our options assessment relied on inputs from a small number of key stakeholders, or a small number of secondary sources. We are confident that the stakeholders consulted represent a significant proportion of relevant markets, and all analytical outputs were cross-checked and subjected to internal reviews. However, a certain level of uncertainty remains around the assumptions made in our stock model.

Furthermore, whilst there is comprehensive market data available on mobile phone sales and shipments, we found a lack of comprehensive market statistics on standalone chargers and the illicit market. Therefore, data on standalone chargers and illicit markets are mainly drawn from the consumer panel survey and stakeholder consultations, leaving some residual uncertainty.

Finally, there might be disruptive technological change which could render the focus on mobile phone chargers irrelevant, and instead raise questions on harmonisation of novel products in consumer electronics. This study did not attempt to
undertake a comprehensive horizon scanning exercise to factor in potential future developments of new technology in this field.
3 The current situation

The European Commission is considering a new initiative to limit fragmentation of the charging solutions for mobile phones (and potentially other portable electronic devices). This chapter summarises the policy, technological and market context of this initiative, and provides an assessment of the main problems it is intended to address, as well as other important considerations, such as the views of key stakeholders about possible unintended effects.

3.1 Policy context

In June 2009, following a request from the European Commission, major producers of mobile telephones agreed to sign a Memorandum of Understanding ("MoU") to harmonise chargers for data-enabled mobile telephones sold in the EU.1 The signatories2 agreed to develop a common specification based on the USB 2.0 micro-B interface, which would allow full charging compatibility with mobile phones to be placed on the market. For those phones that did not have a USB micro-B interface, an adaptor was allowed under the terms of the MoU. The MoU expired after two letters of renewal in 2014.

A study carried out by RPA in 20143 found that the MoU signed in 2009 was effective at harmonising charging solutions and improving consumer convenience. Compliance rates were very high (99% of smartphones sold in 2013 were compliant with the MoU), although it should be noted that one major manufacturer continued to use proprietary charging solutions (Apple switched from its 30-pin connector to the Lightning connector in 2012), which were compliant by virtue of Apple having made an adaptor available for purchase. The study also recognised that decoupling 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, hence limiting the expected benefits for the environment.

Ever since the MoU expired, the European Commission has been trying to foster the adoption of a new voluntary agreement. The European Parliament and the Council also called in 2014 for renewed efforts to complete the harmonisation of chargers.4 Relevant provisions were included in the Radio Equipment Directive (RED)5 adopted in 2014: Article 3(3)(a) defines as one of the "essential requirements" for all radio equipment (including mobile phones) placed on the market that it "interworks with accessories, in particular with common chargers". Recital 12 further specifies that interoperability between radio equipment and accessories such as chargers "simplifies the use of radio equipment and reduces unnecessary waste and costs" it goes on to argue that a "renewed effort to develop a common charger for particular categories or classes of radio equipment is necessary", and in particular, that "mobile phones that are made available on the market should be compatible with a common charger.*

Following several rounds of internal discussions within Digital Europe (the European organisation that represents the digital technology industry) and exchanges of views with the Commission, the industry proposed a new MoU on the future

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1 For more information on the Commission's campaign, as well as the text of the 2009 MoU, see: https://ec.europa.eu/growth/sectors/electrical-engineering/tec-directive/common-charger_en
2 The MoU was originally signed by 10 companies, and four other companies signed it later. Original signatories: Motorola, LG, Samsung, RIM, Nokia, Sony Ericsson, NEC, Apple, Qualcomm and Texas Instruments. Subsequent signatories: Emblaze Mobile, Huawei Technologies, TCT Mobile and Atmel.
3 RPA (2014) Study on the Impact of the MoU on Harmonisation of Chargers for Mobile Telephones and to Assess Possible Future Options
common charging solution for smartphones in March 2018. The seven signatories agreed to "gradually transition to the new common charging solution for Smartphones based on USB Type-C", while noting that it has the ability to also be the "common charging interface for other types of portable electronic equipment". The MoU covers wired charging solutions, and considers the following cable assemblies to be compliant:

- a cable assembly that is terminated on both ends with a USB Type-C 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 connector.

However, the Commission has refused to endorse the new MoU, stating that it does not fully align with the EU's harmonisation objectives, which seek to limit fragmentation of the charging solutions for mobile phones and similar devices. The new MoU continues to allow for proprietary solutions ("vendor-specific connect means"), which the Commission no longer considers justified in view of the technical advantages provided by the introduction of the USB Type C. Therefore, according to the Commission, the new MoU would neither address the remaining fragmentation of the chargers, nor exclude the possibility of other new proprietary solutions emerging in the future.

In a letter sent to Commissioner Elżbieta Bienkowska in October 2018, a number of MEPs also expressed their disappointment with the Memorandum of Understanding, 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." They therefore urged the Commissioner to "take a decisive action in the direction of adopting a delegated act on this matter", making use of the power conferred to it under Article 44 of the RED.

The European Commission argues that further harmonisation would lead to increased consumer convenience, as they would be able to charge not only mobile phones but potentially also other portable devices with a common cable (and charger), as well as being offered the option of retaining existing chargers and purchasing mobile phones without chargers for a lower price. A harmonised solution, according to the Commission's initial analysis, is also expected to reduce the number of counterfeit chargers in the market, reduce the import needs of chargers (as consumers could keep using their old chargers), and reduce electronic waste. At the same time, the Commission recognises that any further harmonisation should not limit innovation, i.e. the development and diffusion of new generations of chargers.

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7 Apple, Google, Lenovo, LG Electronics, Motorola Mobility, Samsung, and Sony Mobile
3.2 Key technological developments

Since 2009, a number of important technological developments have taken place that have improved the performance of charging solutions and introduced new technologies to consumers. This section provides an overview of the main features that influence interoperability, including the EPS and the cable assembly, and the status of wireless charging.

A charging solution is formed by three main elements: the external power supply (EPS), a cable assembly connecting the EPS to the device, and the battery included in the device. For a device to charge, these three elements need to be interoperable. Charging solutions are normally designed ad-hoc to meet the devices' requirements, defined as "charging profile". The charging profile describes the variation of the current and the voltage during the charge, and depends on the type of battery and the recharge time. Interoperability, in summary, relies on the following:

a. EPS providing the current and voltage that the battery needs, determined by the battery's charging profile;

b. A cable connecting the EPS to the device supporting the power being transmitted, with plugs (connectors) at both ends that are compatible with the EPS and the device.

The External Power Supply (EPS)

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. 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.10

According to the interviewees consulted for this study, this standard was widely adopted by the industry. As technology evolved and smartphones required higher power than 7.5W (the maximum power allowed by the IEC 62684 is 5V at 1.5A), new technologies emerged to cover this need. For example, in 2013 Qualcomm released Quick Charge 2.011 12, which provided maximum power of 18W by increasing the current and the voltage of the common charger. Since then, Qualcomm has released Quick Charge v3, v4 and v4+. Quick Charge comes with Snapdragon devices and it has been adopted by a large number of mobile phone manufacturers, such as Samsung, Motorola, OnePlus, Oppo, LG, Xiaomi, and Sony.

In parallel, the USB Promoter Group, formed by 100 members of USB-IF10, was working to develop new battery charging specifications. In 2013 it set a cooperation agreement with IEC to support global recognition and adoption of USB technologies in international and regional standards and regulatory policies. As a result of the work carried out by the USB Promoter Group and USB-IF, IEC published in 2016 the standard series IEC 62680. This standard series set the specifications for USB Power Delivery (IEC 62680-1-2) and USB Type-C (IEC 62680-1-3). Both standards were last revised in 2018.

10 IEC 62684:2018 defines interoperability based on legacy USB technologies and does not cover charging interfaces that implement IEC 62680-1-3, IEC 62680-1-2 and IEC 63002
11 Presentation prepared by Qualcomm for a meeting with the European Commission, DG GROW, on 8 September 2016
12 The USB-IF is a non-profit industry group. It defines itself as "the support organization and forum for the advancement and adoption of USB technology as defined in the USB specifications".
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 smartphone). 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, such as Apple, Google, and Huawei. Samsung has recently announced new charging solutions based on USB PD.

The USB Type-C specification is intended as a supplement to the existing USB 2.0, USB 3.1 and USB PD specifications. It defines the USB Type-C receptacles, plugs and cable assemblies. This specification also sets charging requirements up to 15W, and specifies the use of USB PD if the charge exceeds 15W.

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. Qualcomm's Quick Charge v4 and v4+ incorporate PPS and therefore is compatible with USB PD.

Interoperability of the "USB PD family" is defined by the standard IEC 63002, released in 2016. This standard provides guidelines for 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.

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

Table 2: Typology of external power supply (EPS) for mobile phones

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

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, and triangulated this data with data provided by IDC on shipments of mobile phones per model, in units, in 2018. Based on this, we estimate 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. We assume that a large proportion of these devices incorporated the latest Quick Charge solutions (v4 and v4+).

The cable assembly

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” (IEC 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 and announced by the USB-IF in 2014, and IEC published the standard in 2016. The IEC 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 Apple’s proprietary connector, Lightning, which has been incorporated in all iPhones, iPads and iPods since 2012, and continues to be used in the last generation of iPhones launched in 2019. However, some other devices launched recently by Apple, however, include USB Type-C (e.g. iPad Pro 11-inch, iPad Pro 12.9-inch and Mac: 12 inch MacBook, MacBook Air, and MacBook Pro-Thunderbolt 3, to mention a few).

Table 3. Maximum power and speed for data transfer supported by USB connectors

<table>
<thead>
<tr>
<th>Type of connector</th>
<th>Latest specification it supports (power)</th>
<th>Latest specification it supports (data transfer)</th>
<th>Max Power</th>
<th>Max data transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB micro-B</td>
<td>IEC 62684</td>
<td>USB 2.0</td>
<td>7.5 W</td>
<td>480 Mbps</td>
</tr>
<tr>
<td>USB A</td>
<td>USB PD (IEC 62680-1-2)</td>
<td>USB 3.2</td>
<td>100W</td>
<td>20 Gbps*</td>
</tr>
<tr>
<td>USB Type C</td>
<td>USB PD (IEC 62680-1-2)</td>
<td>USB 4</td>
<td>100W</td>
<td>40 Gbps</td>
</tr>
</tbody>
</table>

*Maximum data transfer of USB A may be increased up to 40 Gbps with Thunderbolt (Intel’s proprietary solution)

Wireless charging

Wireless charging is an incipient technology (meaning that it is currently situated at the beginning of the life cycle) to charge portable devices. At the moment, its energy efficiency is around 60%, whereas energy efficiency for wired technologies is close to 100%. There are three main technologies for wireless charging: Airfuel, Qi and PMA:

- Power Matters Alliance (PMA) was a global, not-for-profit, industry organisation whose mission was to advance a suite of standards and protocols for wireless power transfer.

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13 According to interviews conducted with technical experts.
PMA was merged with Alliance for Wireless Power (A4WP) in 2015 to form AirFuel Alliance, an open standards organisation formed by companies in the field of consumer electronics and mobile technology. It has developed two wireless charging technologies: AirFuel Resonant and Airfuel RF.

Qi was developed by the Wireless Power Consortium, formed by Apple, Google, LG Electronics, Philips, Qualcomm and Samsung, amongst others.\textsuperscript{14}

Qi and PMA seem to have been the preferred technologies by mobile manufacturers to date. Most smartphones use the Qi technology, although some devices, including Samsung’s, are also compatible with PMA. Qi was released in 2008, and by February 2019 there were over 160 devices which had Qi built-in.\textsuperscript{15} Wireless chargers only work with compatible devices. The iPhone X, iPhone 8, and many Android phones, including Huawei, allow wireless charging.

IEC TC 100, the IEC Technical Committee for “Audio, video and multimedia systems and equipment”, has standardised and published two documents on wireless charging protocols: IEC 63028 (AirFuel Wireless Power Transfer System Baseline System Specification) and IEC PAS 63095 (The Qi wireless power transfer system power class 0 specification). According to the information provided by interviewees, there are other standards being developed by IEC TC 100 for energy efficiency related to wireless charging. It is foreseen that new technologies will be reviewed/standardised by IEC TC 100 when they become more mature.

3.3 The market for mobile phone chargers

This section provides an overview of the current market for mobile phone chargers, including recent sales trends for key charging technologies sold “in the box” with mobile phones, as well as estimates of chargers sold separately. Based on this, we introduce the stock model we have developed to provide an indication of the mobile phone chargers that are currently in circulation and/or in use.

Market trends for mobile phone chargers sold “in the box” (2016-2018)

Overall shipments of mobile phone chargers sold together with mobile phones can be inferred from sales data on mobile phones across the EU. Across 2016-2018, overall unit sales of mobile phones fell by 10% (from 178 million to 161 million units), despite a 5% increase in the value of sales. The largest markets for mobile phones (and hence, chargers sold together with mobile phones) in the EU were the United Kingdom, Germany, France, Italy and Spain.

The market share of different charging technologies sold can be approximated by disaggregating overall phone sales by phone model and their respective charging solution. Figure 2 below shows how the market shares for charging technologies – i.e. the connectors at the device end – has changed from 2016-2018.

\textsuperscript{14} See full list of members here: https://www.wirelesspowerconsortium.com/about/board

\textsuperscript{15} Source: https://qi-wireless-charging.net/qi-enabled-phones/ (accessed on 28 June 2019)
The market share of chargers using Lightning connectors has stayed relatively consistent over the period from 2016 to 2018 (slightly above 20%). The market segments covering non-Lightning technologies have seen a clear trend towards uptake of USB Type C connectors, and are suggesting relatively rapid convergence towards this solution overall. The market share held by mobile phone chargers with a USB Type C connector grew from 2% to 29% between 2016 and 2018. The market share held by USB micro-B phones has fallen from 77% to 50%, as devices with USB Type C charging solutions gradually entered the market.

As USB Type C connectors are currently used primarily in higher-end (and therefore more expensive) phones, it is noticeable that the replacement rate in countries with lower average earning has been much slower. In 2018, sales of chargers with USB micro-B connectors still held the highest market share in Greece (76%), Portugal, Poland and Romania (68% respectively) and the lowest market share in Denmark (24%) and Sweden (25%).
All data presented above relates to the connectors at the device (mobile phone) end. As regards the connectors at the external power supply (EPS) end, it is worth noting that, in 2018, practically the totality of chargers sold with phones used detachable cables with USB Type-A connectors. However, the first chargers with USB Type-C connectors at the EPS end started to appear on the European market in late 2017 (launched by Google), although they still accounted for less than 0.1% all mobile phone shipments in 2018 (according to IDC data). This proportion is expected to start to begin to grow from 2019, as other major manufacturers (including Samsung and Apple) have included chargers with USB Type-C EPS connectivity in some of the models they have launched in 2019.

Sales of fast charging solutions sold together with mobile phones have risen almost five-fold since 2016, to 71 million units in 2018, representing 44% of all sales in 2018. Sales of fast charging solutions sold with a USB type C connector grew faster than those with Lightning connectors, in line with overall market trends discussed above.
Another major technology change being introduced into the market is wireless charging. 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 (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). The largest share of wireless enabled phones sold throughout 2016-2018 were Apple phones. This can be expected to change in 2019 though, with a number of new high tier mobile phones by various manufacturers now offering wireless charging functionality.
They exclude phones which require additional accessories other than wireless chargers to be purchased separately to ‘activate’ the wireless charging function. Data for Estonia, Latvia, Lithuania, Slovenia imputed based on Eurostat population statistics (Eurostat 2018).

Chargers sold separately

Although almost every phone is supplied with a charging solution in the box, there remains a significant market for chargers sold separately. In the absence of specific data for this market, we have used the consumer panel survey carried out as part of this study to estimate its approximate size. According to respondents, 16.8% of the chargers in use were bought separately. This percentage was applied in the stock model (see below), and results in an estimated 31 million units sold separately in 2018. This figure is in the same ranges as estimates in the 2014 RPA report3 (9-14%) and in the 2015 Charles River Associates report7 (18-34 million units). Based on the survey responses, reasons for these purchases included, in order of reported frequency, phone charger cable failure, the desire to have multiple chargers, forgetting their charger whilst travelling and losing their original charger.

On the point of decoupling, as noted above, we find that almost every phone is supplied with a charging solution in the box. In the 2014 RPA study a handful of pilots and initiatives were noted where it was possible to purchase a phone without a charger. They therefore reached the conclusion that in 2012 around 0.02% of the market was supplied without chargers, and in 2013 they estimated this had increased to 0.05%. However, research as part of this study has found no evidence on the continued success or existence of such pilots and programmes. Only one supplier, Fairphone, was noted for selling phones without a charger. They remain a very niche player in the market, with a very small market share. They note that they do sell chargers on their website, and estimated in interview that around a quarter of their customers also purchased chargers when purchasing a Fairphone.

Estimating the total stock of chargers

The market data presented at the start of this section was used to populate a stock model for the number of chargers currently in use. A baseline scenario was constructed which models the stock of chargers each year based on additions (sales) and subtractions (disposals) from the stock. We modelled the charger market in relation to the following combinations of charging solution components.

Table 4: Charging solution components modelled within the stock model

<table>
<thead>
<tr>
<th>EPS type</th>
<th>Cable types</th>
<th>Adaptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB A - standard</td>
<td>USB A – USB Micro-B</td>
<td>None</td>
</tr>
<tr>
<td>USB A – fast charger (USB PD)</td>
<td>USB A – USB C</td>
<td>USB Micro B – USB C</td>
</tr>
<tr>
<td>USB A – fast charger (Quickcharge)</td>
<td>USB A – Proprietary</td>
<td>Proprietary – USB Micro B</td>
</tr>
<tr>
<td>USB C - standard</td>
<td>USB C – USB Micro-B</td>
<td>USB C – Proprietary</td>
</tr>
</tbody>
</table>

---

3 RPA (2014)
7 Charles River Associates (2015): Harmonising chargers for mobile telephones Impact assessment of options to achieve the harmonisation of chargers for mobile phones
The stock model estimates the stock of chargers as shown in the following figures, which split the stock into EPS and cable types. Figure 6 shows the stock model estimation of the number of EPS in use from 2014-2028. This shows a total of around 800-900 million typically in use, with those with USB Type-A connectors dominating the types in use, and although USB Type-C EPS are already starting to be introduced in 2019, they only gain a noticeable share in the total stock from 2022 onwards. Figure 7 shows the cable stock over the same period. This shows that up to 2017 the cable stock is almost entirely USB Micro-B or Proprietary connectors on the device side. USB C connectors start to show in the stock from 2018 onwards. It also shows that, similarly to the EPS, the stock of cables are almost exclusively USB A on the EPS side, with USB C becoming noticeable only from 2022 onwards. This switch is made by cables with proprietary or USB C on the device side. By the end of 2028 it is estimated that USB Micro B connectors are almost redundant and USB C (device) side connectors dominate the stock, along with proprietary cables.

Figure 6: Stock model estimation of EPS types in use 2014-2028 – Baseline scenario
The key assumptions underpinning these stock model results for the baseline scenario are presented below in Table 5. Specific assumptions relevant to the calculation of impact are presented in the relevant sections of chapter 5.

Table 5 Key assumptions underpinning baseline scenario in stock model

<table>
<thead>
<tr>
<th>Additions</th>
<th>Disposals</th>
</tr>
</thead>
</table>

Figure 7 Stock model estimation of charger cable types in use 2014-2028 - Baseline scenario
### Additions
- 100% of phones are supplied with chargers as no material decoupling is currently noted.
- Phone sales are estimated 2013-2018 from specific market data; pre-2013 estimated from Prodcom data.
- Apple market share 2008-2012 held at 2013 level.
- Sales are held at the 2018 level between 2019-2028, Apple (proprietary) market share also held to 2018 level (21.4%) between 2019-2028.
- Phone sales are split per charger type as per market data 2016-2018. Prior to 2015 chargers were either USB A - USB Micro B or USB A - Proprietary.
- Assumed only Apple provides proprietary charging solutions.
- Sales of standalone chargers (separate from phones) conform to the same types as those provided with phones in the same year.
- First fast charging and USB-C (device side) solutions introduced in 2016. Growing market share since then.
- Starting 2019 Apple (proprietary) switches to EPS with USB C and fast charging as standard. Completed switch by 2022.
- Starting 2019 fast charging EPS USB C - USB C gains market share, growing to entire market by 2024.
- EPS fully converge on USB-PD fast charging standard by 2022.
- EPS (all types) USB A - USB C grows share to 2020, peaking at 46%. Subsequently this rapidly declines as the switch to EPS USB C gathers pace.
- EPS USB A - USB Micro B share continues to decline from 50% in 2018 to 0% by 2022.

### Disposals
- Assumes disposal in two stages over time, first stage of disposal based on consumer survey, with timing on basis of:
  - Year T+0: 2%
  - Year T+1: 6%
  - Year T+2: 33%
  - Year T+3: 25%
  - Year T+4: 11%
  - Year T+5: 9%
  - Year T+6: 14%
- In this first stage, disposal takes one of three forms, in the following proportions – 31% disposed / 51% stored (not-used) / 18% remain in use. These ratios based on consumer survey results.
- Two previous assumptions are multiplied to estimate disposal methods each year. E.g. In year 2, 33% × 31% = 10.4% disposed, 33% × 51% = 16.9% stored.
- Disposals to 'stored' are removed from the stock, as these are not 'in-use', but these are not counted in disposals as they did not yet enter the e-waste chain.
- In a second stage, the remainder of stock (stored and in-use) after year 6 is assumed to be disposed in following 4 years. Meaning that after 10 years all chargers are assumed disposed.
- Disposals are split by charger component and type proportional to the types in original year of addition to the stock.
- Disposals are split between recycling and incorrect disposal (general waste). In 2019 this proportion is 75:25. Recycling rate increases by 1% point per year to 2028, consistent with targets in WEEE Directive.

### 3.4 The market for chargers of other portable electronic devices

As noted above (section 3.1), an initiative for a common charger could potentially also be envisaged to cover portable electronic devices other than mobile phones. In this section, we briefly discuss the charging profiles of certain other devices (to assess the extent to which these are similar to mobile phones), summarise key market trends for such devices, and consider the extent to which they are typically sold with or without chargers (decoupling). More detailed information on each of these elements is available in Annex D.

**Charging profiles**

The current (measured in ampere), voltage (measured in volts) and power (measured in watts) are the key parameters that define any electrical circuit. The power combines the voltage and the current ($P = A \times V$), so this is the key metric of interest when comparing electric devices. The current flow defines the section of the connectors and wires. It generates
heat that must be dissipated, otherwise the component can be combusted. Connectors of tablets, e-readers, wearables and cameras can also be used for communication between the device and a computer. Therefore, the connector (e.g. USB cable) must be also compliant with communication protocols to guarantee a safe transmission of data.

Mobile phones’ charging power typically ranges between 5W and 18W if they include USB Power Delivery (PD) technology. Devices with similar characteristics include, for instance, e-readers, wearables, and cameras, as illustrated in Table 6. Laptops, however, require more power, which poses technical challenges when it comes to sharing the EPS with a mobile phone. USB PD offers enough power to charge laptops. However, given that mobile phones typically do not need this much power, the chargers included in the box with phones do not provide the power that laptops need. This means that, while these chargers can charge a laptop, but only very slowly. On the other hand, the chargers included in the box with the laptops could charge mobile phones (provided they come with the right connectors) using only the power required by the mobile phone and ensuring a safe charge for both the user and the device. As a consequence of this, if laptops were to be included within the scope of the new regulation or voluntary agreement, the mandated charger would need to provide higher power capacity than what mobile phones typically need.

Table 6: Typical charging characteristics of portable electronic devices

<table>
<thead>
<tr>
<th>Device</th>
<th>Current</th>
<th>Voltage</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphones</td>
<td>1A – 2.5A</td>
<td>5V – 12V</td>
<td>5W – 18W</td>
</tr>
<tr>
<td>Laptops</td>
<td>1.5A – 3A</td>
<td>5V – 20V</td>
<td>30W – 65W</td>
</tr>
<tr>
<td>E-readers</td>
<td>0.5A – 2.5A</td>
<td>3.7V – 5.35V</td>
<td>10W – 12.5W</td>
</tr>
<tr>
<td>Wearables</td>
<td>0.1A – 2A</td>
<td>3.7V – 9V</td>
<td>0.7W – 10W</td>
</tr>
<tr>
<td>Cameras</td>
<td>0.2A – 1.89A</td>
<td>3.6V – 8.4V</td>
<td>1W – 10W</td>
</tr>
<tr>
<td>Sport cameras</td>
<td>1A – 3.25A</td>
<td>3.9V – 20V</td>
<td>2.4W – 65W</td>
</tr>
<tr>
<td>Videogame devices</td>
<td>0.8A – 3A</td>
<td>3.65V – 15V</td>
<td>3W – 20W</td>
</tr>
</tbody>
</table>


Another challenge to ensure interoperability between the charging solutions of mobile phones and other devices is the connector at the device end. While many of the devices in the sample we looked at use USB micro-B or (less frequently) USB Type-C connectors, certain devices require connectors with specific characteristics to meet the functions the device is designed for or to fit within confined spaces. This is the case, for instance, of small-size wearables that are submergible, or devices that are intended to function in extreme environments. The form of the device also limits the type of connector it supports. Examples provided by interviewees where USB Type-C (or other types of USB) may not be suitable include: health devices, such as hearing aids, household appliances, or some Internet of Things (IoT) devices used in agriculture. These devices frequently use proprietary connectors and, more recently, wireless chargers. A wireless charger is generally composed of a platform and a cable with a USB connector at both ends of the cable. The device, for instance a smartwatch, is charged while placed on this platform.

A variety of connectors, in fact, is used in battery-operated devices other than smartphones. An overview of the different types of connectors used by different types of devices is presented in Table 7.
Table 7: Types of connectors used in other portable devices

<table>
<thead>
<tr>
<th>Device</th>
<th>USB micro-B</th>
<th>USB Type C</th>
<th>Proprietary solutions</th>
<th>Other USB / wireless</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laptops</td>
<td>Laptops cannot be charged with USB micro-B.</td>
<td>A small number of models in our sample (3 out of 11) have USB Type C connectors.</td>
<td>Most of the laptops in our sample (8 out of 11) are based on proprietary solutions.</td>
<td>N/A</td>
</tr>
<tr>
<td>Tablets</td>
<td>A small number of models in our sample (3 out of 10) have USB micro-B connectors.</td>
<td>A small number of models in our sample (3 out of 10) have USB Type C connectors.</td>
<td>Most of the tablets in our sample (4 out of 10) are based on proprietary solutions.</td>
<td>N/A</td>
</tr>
<tr>
<td>E-readers</td>
<td>Nearly all the e-readers in our sample (7 out of 8) have USB micro-B connectors.</td>
<td>Only one e-reader in our sample has a USB Type C connector.</td>
<td>None of the e-readers in our sample use proprietary solutions.</td>
<td>N/A</td>
</tr>
<tr>
<td>Wearables</td>
<td>Nearly half of the wearables in our sample (7 out of 15) have USB micro-B connectors.</td>
<td>Only one wearable uses a USB Type C connector.</td>
<td>Some wearables in our sample (6 out of 15) use proprietary solutions.</td>
<td>One wearable uses a wireless charger</td>
</tr>
<tr>
<td>Cameras</td>
<td>Most of the cameras in our sample (9 out of 12) have USB micro-B connectors.</td>
<td>Only one camera in our sample uses a USB Type C connector.</td>
<td>A small number of models in our sample (2 out of 12) have proprietary solutions.</td>
<td>N/A</td>
</tr>
<tr>
<td>Sport cameras</td>
<td>Nearly half of the sport cameras in our sample (5 out of 11) have USB micro-B connectors.</td>
<td>Some sport cameras in our sample (4 out of 11) use USB Type C connectors.</td>
<td>None of the models in our sample use proprietary solutions.</td>
<td>A small number of models in our sample (2 out of 11) use USB mini-B connectors.</td>
</tr>
<tr>
<td>Videogame devices</td>
<td>Most of the videogame devices in our sample (5 out of 8) have micro B connectors.</td>
<td>One device uses a USB Type C connector.</td>
<td>One of the devices in our sample has a proprietary connector.</td>
<td>One model uses a USB mini-B connector.</td>
</tr>
</tbody>
</table>


Laptops are the type of device with the highest share of proprietary charger connectors among all the types of portable devices analysed in this study, although USB Type-C is used in a small number of models. This may be due partly to the fact that, according to some of the stakeholders interviewed for this study, there are technical issues related to the inclusion of USB Type-C chargers on laptops, as certain models need more than 100W, which is the maximum power provided by USB PD.

Market trends for other portable devices

In the absence of comprehensive and robust sales data for portable electronic devices, market trends were evaluated by using alternative sources. Market data for devices other than mobile phones was obtained from a variety of datasets on shipments and imports. Particularly data from Comtrade describing imports into the EU from the world should provide a
good indication of the relative volumes of the markets for different portable devices and overall trends, as nearly all such devices are manufactured overseas (usually in Asia)\(^\text{18}\).

According to Comtrade, in 2017, 200.7 million portable devices were imported into the European Union (12.5 million smartwatches, 54.2 million digital cameras, 59.6 million videogame devices, and 74.4 million laptops), down from 219.3 million units imported in 2013\(^\text{19}\). For some devices, the trend over the years was downwards. The number of laptops imported into the EU fell from 101.7 million units in 2013, to 100 million in 2014, to 84.4 million in 2015, followed by a further decrease to 74.9 million units in 2016 and 74.4 million units in 2017. Imports of smartwatches grew consistently until 2016 (14.8 million units in 2013, 25.1 million units in 2014, 27.3 million units in 2015, and 28.9 million units in 2016), but sharply fell to 12.5 million units in 2017. Imports of digital cameras remained overall constant over time: they went from 52.7 million units imported into the EU in 2013 to 54.2 million units in 2017 but were between 48.9 million and 49.9 million units between 2014 and 2016. Videogame devices displayed a more irregular pattern: imports increased to 55 million units in 2014 compared to the 50.1 million units in 2013, but then dropped to 50.2 million units in 2015 and to 49.8 million units in 2016, before surging to 59.6 million units in 2017.

**Decoupling**

As was underlined in many interviews with industry stakeholders, decoupling is almost non-existent at present in the case of mobile phones and in the case of larger electronic devices, particularly laptops:

From an analysis of a sample of devices of different types, it was confirmed that decoupling is rare among larger devices. All the laptops considered in the market analysis were sold with an EPS included in the box. Industry stakeholders stressed that consumer convenience, technical, safety and liability concerns were the reason for this. Similarly, all the tablets in the sample analysed for this study were sold together with a charging cable and EPS, regardless of the type of connector (proprietary, USB micro-B or USB Type-C). Digital cameras and battery-operated videogame devices were also sold together with the EPS and the charging cable.

On the contrary, nearly all small devices, including action cameras, e-readers, and wearables were sold only with a charging cable, but without an EPS. In fact, these devices were sold together with an EPS only when a proprietary connector was used, whereas if they had a USB-based connector, the EPS was normally not included in the box.

During interviews, manufacturers underlined how for certain products, finding a charger in the box is part of the consumer experience, especially for high-end products; they argued that mandating decoupling could potentially lead to poor consumer experience, in addition to safety-related problems. In addition to these considerations, one industry stakeholder stressed that decoupling would imply reforming the way safety tests are currently carried out, as devices are normally tested together with their chargers; not providing a charger with a device could mean that the scope of testing could be expanded, resulting in longer time before a product can be commercialised and higher financial costs.

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\(^{19}\) Data from Comtrade is based on specific TARIC codes for each product: smartwatches (9102120000), digital cameras (8525803000), videogame devices (9504500000), and laptops (8471300000). It has to be noted that the TARIC code for smartwatches also includes normal watches; the codes for digital cameras, videogame devices, and laptops may comprise other similar devices, although their proportion of other devices relative to the devices of interest is expected to be negligible. The data used refers to imports into the EU from the world. For further details, please refer to Annex D.
3.5 The consumer perspective

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 consumer associations which participated in the Public Consultation promoted by the European Commission; similar issues were also highlighted in a series of interviews with representatives of consumer organisations that were contacted to provide their views on the current situation.

Nearly all the consumer associations involved in the study stressed that the presence of different types of connectors and chargers is inconvenient for mobile phone users. 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. It was underlined how the absence of clear labelling may make it hard to identify the differences among chargers, or to understand whether a charger is suitable for a given device. Clear labelling was also indicated as a necessary measure to distinguish chargers with different charging features.

Consumer organisations seemed to agree that, at present, most electronic devices, and in particular mobile phones, are sold exclusively with a complete charger in the box. This was said to narrow consumer choice, as well as making consumers incur higher financial costs. Further to this, some stakeholders highlighted that most consumers need more than one charger for the same device (e.g. for home and for the workplace), and the lack of harmonisation forces consumers to purchase new chargers separately, as older chargers are not suitable for newer devices. Consumer associations stressed that this resulted in accumulating old chargers at home or at the workplace. Consumer organisations also raised issues related to the environmental aspects linked to the current fragmentation, and to risks from substandard chargers that do not comply with relevant safety standards (for more on these issues see sections 3.6 and 3.9 below).

76% of the European citizens who participated in the European Commission’s Public Consultation on mobile phone chargers agreed (a little under half of them “strongly”) that the current situation results in inconvenience for mobile phone user. Types of inconvenience reported by a majority of respondents were the need for users of mobile phones and/or other portable electronic devices to have several different chargers, which occupy space and/or can lead to confusion; and that it can be difficult for mobile phone users to access a suitable charger when away from home, at work, travelling, etc. Nearly 70% also felt the current situation results in financial costs for mobile phone users, while 62% cited performance issues (regarding the time it takes to charge phones). On the other hand, 32% of respondents agreed that the current situation gives consumers the ability to choose from a wide range of charging options.

Results of the consumer panel survey

The sections below highlight the main findings from the survey analysis. Unlike the Public Consultation, the survey was undertaken with a broadly representative sample of consumers in ten EU Member States, and therefore provides a good indication of consumers’ actual ownership and use of chargers, and of the extent to which the issues and problems reported by those who tend to feel most strongly about them (and therefore chose to take part in the Public Consultation) are felt among consumers at large.

How many mobile phone chargers do consumers own and use?

In summary, the results of the consumer panel survey suggest 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.
Across all respondents, the average number of chargers owned by all respondents was three, which is consistent for both iPhone and non-iPhone users. When disaggregating these results by age, 18 to 24-year olds owned an average of four chargers, compared to three chargers for respondents in all other age categories. 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.

Survey respondents were also asked about how they acquired their current mobile phone chargers. For participants who used only one charger regularly (48% of all respondents), 88% responded that it was provided with their current mobile phone, with only 5% of chargers bought separately (as shown in Figure 8). Second and third chargers in use were more often supplied separately (28% and 37% respectively) or from a previous mobile phone or device (20% and 17% respectively).

Figure 8: The way in which single and multiple chargers are supplied

For each charger you are currently using, can you please state whether they were supplied together with a mobile phone?

- Provided with a mobile phone I currently use: 88%
- Bought it separately: 5%
- Provided with an old mobile phone: 4%
- Provided with another device: 2%
- I don't know: 2%

N = 5002, Source: Ipsos consumer survey (2019)

How do consumers use mobile phone chargers?

In summary, a little more than a third of consumers use their mobile phone charger to charge other mobile phones and/or other electronic devices (in particular tablets). When doing so, slightly over half of respondents clarified they use both the cable and the external power supply together, with the remainder only using one or the other.

While 63% of survey respondents reported to only use their charger(s) to charge one specific phone, 37% also use their charger to charge other mobile phones, electronic devices or both. iPhone users had an increased likelihood to do this compared to non-iPhones users (39% and 36% respectively), which may suggest that iPhone users tend to charge other Apple devices. Approximately 41% of all respondents aged 18 to 44 charge other mobile phones, electronic devices or both, but this figure falls with age, decreasing to 29% for respondents aged 65 and above.

For those respondents who are using their mobile phone charger to charge other electronic devices, tablets were the most popular alternative devices (65%) followed at a considerable distance by wireless speakers (19%) and E-readers
Further detail is provided in Figure 9 below. The proportion of respondents’ mobile phone chargers used to charge tablets increases with age, from 45% to 65% (18 to 24-year olds and 65 years and above respectively). The youngest age group shows the largest proportion of chargers used for wireless speakers and headphones (36% and 34% respectively) compared to those aged 65 and above which show digital cameras and navigation/GPS devices as the most commonly charged alternative (15% and 14% respectively).

Figure 9: Other devices charged with respondent’s current mobile phone charger

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Non-iPhone Users</th>
<th>iPhone Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tablet</td>
<td>62%</td>
<td>75%</td>
</tr>
<tr>
<td>Wireless speakers</td>
<td>21%</td>
<td>15%</td>
</tr>
<tr>
<td>E reader</td>
<td>17%</td>
<td>20%</td>
</tr>
<tr>
<td>Wireless earphones</td>
<td>8%</td>
<td>9%</td>
</tr>
<tr>
<td>Other</td>
<td>17%</td>
<td>15%</td>
</tr>
<tr>
<td>Fitness tracker or activity band</td>
<td>13%</td>
<td>10%</td>
</tr>
<tr>
<td>Digital camera</td>
<td>12%</td>
<td>10%</td>
</tr>
<tr>
<td>Smartwatch</td>
<td>9%</td>
<td>14%</td>
</tr>
<tr>
<td>Navigation/GPS devices</td>
<td>7%</td>
<td>5%</td>
</tr>
<tr>
<td>Laptop</td>
<td>3%</td>
<td>4%</td>
</tr>
</tbody>
</table>

N = 1057, Source: Ipsos consumer survey (2019)

The majority of respondents (58%) using their mobile phone charger to charge other mobile phones (Figure 10) used both the cable assembly and external power supply unit. Although there was no trend by age, non-iPhone users were more likely than iPhone users to use both the cable assembly and power supply (60% vs 48%) whilst iPhone users were more likely to use either the cable assembly or power supply unit only (12% and 19% vs 10% and 15% respectively).

Similarly, when charging other electronic devices (Figure 11), most respondents (53%) used both the cable assembly and power supply unit. The proportion of respondents doing this increased with age (from 44% to 59% for 18 to 24-year olds and 65-year olds and above, respectively). iPhone users were more likely to use only the power supply unit to facilitate charging compared to non-iPhone users (28% vs 15%), and conversely less likely to use only the cable assembly (10% vs 14%).
From the perspective of non-iPhone and iPhone users, 27% and 25% of respondents reported that charging other mobile phones with their primary mobile phone charger resulted in a significant or slight reduction in its performance. Reductions in charging performance were more frequently reported by those aged 18 to 44-years old.

In contrast, 35% of non-iPhone users and 30% of iPhone users reported no impact on charging performance and said that the charger provided the same level of performance when charging other mobile phones. However, 19% and 32% of survey participants respectively (driven by those aged 55 and above) stated that there was no observable difference in
charging performance when the mobile phone was from the same manufacturer. It must also be noted that 20% and 13% of users respectively did not know the effect of the charger on charging speed when charging other mobile phones.

Problems with chargers experienced by consumers

Participants in the consumer survey were also 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 included as response options (see below). The most commonly cited problems (experienced at least once by around half of respondents) were: having too many chargers taking up space at home and/or at the workplace; not being able to charge mobile phones as fast with other chargers; not being able to charge other electronic devices; and not being able to charge new phones with old chargers. Fewer respondents (around a third) reported being provided a charger when they would have preferred to keep using their old one; problems with access to a compatible charger; confusion regarding which charger to use for which phone and/or other device; and safety issues. However, typically only a minority of respondents (between 35% and 50% of those who reported having experienced each of these issues, or around 15% to 20% of all survey respondents) felt that these were serious problems, i.e. had caused them significant issues.

Figure 12 overleaf presents aggregate responses for all respondents who had experienced problems in the 24 months prior to the survey. More than half of all respondents (both 53%) stated that they could not charge their mobile phones as quickly using other chargers and that they had too many chargers taking up space in either their home or workplace. For these two issues, no significant difference between iPhone and non-iPhone users was reported. Similarly, 49% of all survey participants reported that they could not charge other electronic devices with their charger.

The most commonly cited problems to be either experienced almost every day or on numerous occasions included not being able to charge a new phone with an old charger (18%), having too many chargers at home and/or the workplace taking up space (16%), and not being able to charge other electronic devices with a charger (15%).

When analysing these issues at a model level, iPhone users reported a more significant detriment (the issues presented caused significant issues from time to time or on a regular basis) across all three issues outlined above (68% vs 61%, 60% vs 48% and 53% vs 48%) compared to non-iPhone users. The three issues which showed the largest difference amongst the two types of users were: the respondent was confused about which charger to use with other mobile phones, the respondent could not charge their mobile phone as fast with other chargers and the respondent was confused about which charger to use with other electronic devices (48% vs 40%, 60% vs 48% and 56% vs 47%).

A higher percentage of iPhone users reported that available chargers were incompatible with their phone and that they could not charge other electronic devices with their charger (48% vs 35% and 58% vs 47% respectively). It seems likely that this is due to the fact that Lightning connectors offer less interoperability with non-Apple products than other connector types. Overall, a higher proportion of iPhone users who took part in the survey reported having experienced eight out of the ten issues forms of inconvenience in the past 24 months.

When respondents rated the seriousness of these problems (as shown in Figure 13), the problems perceived to cause the highest degree of inconvenience (those problems that caused significant issues from time to time or on a regular basis) were that respondents could not charge their mobile phone as fast with other chargers, they could not charge their new phone with their old charger and that they had too many chargers taking space in their home or workplace (1,090, 1,075 and 1,068 respectively). When solely analysing problems that caused a significant issue on a regular basis, the inability of
users to charge their new phone with their old charger and the inability to charge other electronic devices with their charger were the most prominent issues faced by all consumers.

At a disaggregated level, iPhone users reported the issues that caused the highest degree of inconvenience were that they could not charge other electronic devices with their charger, only incompatible chargers were available when they needed to charge their phone and the charger eventually became unsafe to use (253, 250 and 243 responses respectively). Again, some of these could be due to a lack of interoperability for iPhone chargers if consumers cannot use it to facilitate charging of other devices or struggle to find a compatible charger when needed. In comparison, non-iPhone users reported that the primary reasons leading to some form of inconvenience were that they could not charge their mobile phone as fast with other chargers, they couldn't charge their new phone with their old phone, and that they had too many chargers in their home or workplace (853, 850 and 830 respectively). This suggests inconvenience faced by non-iPhone consumers when purchasing a new phone which results in a lack of interoperability and an individual level stockpile of chargers.
Figure 12: Share of all respondents experiencing problems with a mobile phone charger

Have you experienced the following problems in the past 24 months with a mobile phone charger?

<table>
<thead>
<tr>
<th>Problem</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have too many chargers taking up space in my home or workplace</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>55%</td>
</tr>
<tr>
<td>I couldn't charge my mobile phone as fast with other chargers as with my charger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4%</td>
</tr>
<tr>
<td>I couldn't charge other electronic devices with my charger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21%</td>
</tr>
<tr>
<td>I couldn't charge my new phone with my old charger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>I was provided a new charger with a new phone although I would have preferred to use a charger I already had</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>I needed to charge my phone, but the available chargers were incompatible with my phone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8%</td>
</tr>
<tr>
<td>I was confused which charger to use for which other portable electronic device</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23%</td>
</tr>
<tr>
<td>The charger became unsafe to use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1%</td>
</tr>
<tr>
<td>I was confused which charger to use for which mobile phone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>Other problems</td>
<td>95%</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Almost every day  On numerous occasions  On a few occasions  Once or twice  Never

N = 5002, Source: Ipsos consumer survey (2019)
Figure 13: Number of respondents by seriousness of problem reported

<table>
<thead>
<tr>
<th>Problem</th>
<th>0</th>
<th>500</th>
<th>1000</th>
<th>1500</th>
<th>2000</th>
<th>2500</th>
<th>3000</th>
<th>3500</th>
<th>4000</th>
<th>4500</th>
<th>5000</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have too many chargers taking up space in my home and/or workplace</td>
<td>779</td>
<td>112</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I couldn't charge my mobile phone as fast with other chargers as with my charger</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I couldn't charge other electronic devices with my charger</td>
<td>774</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I couldn't charge my new phone with my old charger</td>
<td>1294</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was provided a new charger with a new phone although I would have preferred to use a charger I already had</td>
<td>1224</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I needed to charge my phone, but the available chargers were incompatible with my phone</td>
<td>360</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was confused which charger to use for which other portable electronic device</td>
<td>500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The charger became unsafe to use</td>
<td>569</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was confused which charger to use for which mobile phone</td>
<td>720</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- It caused me significant issues on a regular basis
- It did cause significant issues from time to time
- It didn't cause any significant issues and I do not consider it a serious problem

N = 1,564 - 2,624, Source: Ipsos consumer survey (2019)
Actions taken to address problems, and costs incurred

As part of the survey, respondents who experienced one or more of the issues discussed above were also asked what (if anything) they had done to resolve / address the issue(s), and any costs incurred (in terms of time and money). The responses suggest that these costs can be non-negligible, although the results need to be interpreted with a degree of caution due to the relatively small number and high variability of responses, and the fact that the questionnaire did not distinguish between the actions taken / costs of the different types of problems.

Figure 14 outlines the actions taken by consumers to resolve the problems they encountered when using a mobile phone charger. 30% of participants who experienced a problem with their mobile phone charger took no action to alleviate the issues raised previously. Respondents aged 35 and over were more likely not to take any action. The most commonly cited reasons for taking no further action was that either the participant felt that the problem wasn't serious enough (50%) or they felt that it would take too much time and effort (19%).

The most common action taken by respondents who took some form action to resolve the problems reported were that they either used another charger that they already owned, or bought an additional charger (22% and 14% respectively). A slightly higher proportion of non-iPhone users used an alternative charger in their possession (23% vs 18%) when compared to iPhone users.

Figure 14: Action taken to resolve problems experienced with mobile phone chargers

In which way did you take / have you taken action to solve this/these problem(s)?

- Don't know: 1%
- Any other actions: 1%
- Made a complaint to someone other than the company/firm where I obtained the mobile phone charger: 1%
- Made a complaint to the company/firm where I obtained the mobile phone charger: 3%
- Asked the company from where I obtained the mobile phone charger for a price discount: 3%
- Refused: 4%
- Asked the company from where I obtained the mobile phone charger for a refund: 4%
- Bought an adapter: 5%
- Returned the mobile phone charger to the company where I obtained it: 6%
- Asked the company from where I obtained the mobile phone charger for a replacement: 6%
- Bought an additional charger: 14%
- I used one of the other chargers in my possession instead: 22%
- I took no action: 30%

N = 4180. Source: Ipsos consumer survey (2019)
Respondents were also asked whether they had incurred any costs as a result of the problems they reported when using mobile phone chargers. 18% (736 responses) of those facing issues said this was the case (15% of all survey respondents), resulting in an average cost of €35. Costs reported by consumers included the costs of telephone calls, replacing or repairing goods and lost earnings due to not being able to work.

Of those respondents that had experienced any of the problems presented within the survey, 20% reported that they had spent part of their free time attempting to resolve these charger issues (16% of all survey respondents). Across respondents who provided an estimation of the time spent resolving these issues (559), the average was 6 hours. However, the data is heavily skewed by a few responses (with 25 respondents reporting having spent 30 hours or more resolving these problems). This generated a mode of 0.7 hours and a median value of 1.5 hours across respondents.

Relative importance of interoperability when compared to other product attributes of mobile phone chargers

A conjoint module\(^{20}\) was included in the consumer survey to investigate the relative importance of different product attributes of mobile phone chargers. This allowed the study team to investigate how much consumers value certain product attributes (when purchasing a stand-alone charger).

The results of the conjoint experiment demonstrated that price and the type of connector at the EPS and phone end were the most important attributes for consumers when choosing what mobile phone charger to buy. Interoperability with other mobile phones and other devices were the least important of the six attributes included in the conjoint experiment. This suggests that, when purchasing chargers separately, consumers typically have a specific device in mind, and the ability to use chargers across different devices is only a minor factor in their decision-making.

Figure 15: Relative importance of product attributes – mobile phone chargers

\(^{20}\) The conjoint experiment undertaken provided relative utilities for the following product attributes: Interoperability with other mobile phones; Interoperability with devices other than mobile phones; Brand; Charging time; type of phone charger connector at EPS and phone end; Price. This allows to estimate market shares for a charger with any combination of these attributes. See: [https://en.wikipedia.org/wiki/Conjoint_analysis](https://en.wikipedia.org/wiki/Conjoint_analysis)
### Table 8: Conjoint analysis comparison scenarios

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Most favourable option</th>
<th>Least favourable option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interoperability with other mobile phones</td>
<td>Can charge other phones ensuring same performance</td>
<td>Can only charge phone that it was originally intended to charge</td>
</tr>
<tr>
<td>Interoperability with devices other than mobile phones</td>
<td>Can be used to charge any other device</td>
<td>Cannot be used to charge other devices</td>
</tr>
<tr>
<td>Brand</td>
<td>Same brand as my phone</td>
<td>A brand I haven’t heard of</td>
</tr>
<tr>
<td>Charging time</td>
<td>40 minutes</td>
<td>240 minutes</td>
</tr>
<tr>
<td>Type of phone charger connector at EPS and phone end</td>
<td>USB A charger and USB micro-B phone connector</td>
<td>USB C both charger and phone connector</td>
</tr>
<tr>
<td>Price</td>
<td>€10</td>
<td>€50</td>
</tr>
</tbody>
</table>

*N = 4906, Source: Ipsos consumer survey (2019)*

**Consumer value of interoperability with other mobile phones**

Using the results of the conjoint module, the premium that consumers are willing to pay for a mobile phone charger with varying degrees of interoperability and performance can be modelled.

In order to attribute a monetary value for varying degrees of phone charger interoperability and performance, an initial baseline scenario was created for each connector type, as outlined in Table 9. Each baseline for scenario 1 across connector types initially assumes a common set of attributes and that the phone charger can only charge the phone that it was originally intended to charge and cannot charge other phones. An improvement was then made to make the charger interoperable, meaning that it can now charge other phones, but with a reduced charging speed. A percentile monetary premium can then be estimated by adjusting the price of the charger to maintain customer preference shares as outlined in scenario 1 of each connector type.

Scenario 2 outlined in Table 9 assumes that the initial baseline was that the charger is interoperable, i.e. can charge other phones, but with a reduced charging speed. An improvement is then made to ensure identical performance, meaning that the mobile phone charger can now charge other phones ensuring the same charging speed. A similar method can then be used as described above to ascertain the monetary value placed on varying levels of interoperability and performance by consumers. The results of this are summarised below.

**Typical charger with a Lightning connector at the device end:**

- Consumers valued an improvement from no interoperability to interoperability at a price premium of 8%.
- Consumers valued an improvement from interoperability to identical performance at a price premium of 4%.

**Typical charger with a USB micro-B connector at the device end:**

- Consumers valued an improvement from no interoperability to interoperability at a price premium of 20%.
- Consumers valued an improvement from interoperability to identical performance at a price premium of 13%.
Typical charger with a USB Type C connector at the device end:

- Consumers valued an improvement from no interoperability to interoperability at a price premium of 12%.
- Consumers valued an improvement from interoperability to identical performance at a price premium of 8%.

Table 9: Conjoint analysis – price premium for enhanced interoperability and performance of chargers

<table>
<thead>
<tr>
<th>Charger Attributes</th>
<th>Lightning charger</th>
<th>Micro-USB charger</th>
<th>USB C charger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector at the device end</td>
<td>Lightning</td>
<td>USB micro-B</td>
<td>USB Type-C</td>
</tr>
</tbody>
</table>

- Connector at the EPS end: USB Type-A
- Brand: Same brand as the consumer's phone
- Charging time: Can be fully charged in 120 minutes
- Interoperability with portable devices other than mobile phones: Can be used to charge small devices such as smart watches and compact digital cameras

<table>
<thead>
<tr>
<th>Price</th>
<th>€40</th>
<th>€15</th>
<th>€25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenarios</td>
<td>Scenario 1</td>
<td>Scenario 2</td>
<td>Scenario 1</td>
</tr>
<tr>
<td>Interoperability with other mobile phones</td>
<td>Baseline</td>
<td>Can only charge phone that it was originally intended to charge and cannot charge other phones</td>
<td>Can charge other phones, but with reduced charging speed</td>
</tr>
</tbody>
</table>

| Improvement | Can charge other phones, but with reduced charging speed | Can charge other phones ensuring the same charging speed | Can charge other phones, but with reduced charging speed | Can charge other phones, but with reduced charging speed | Can charge other phones ensuring the same charging speed | Can charge other phones ensuring the same charging speed |

| Price premium achieving the same consumer preference share | 8% | 4% | 20% | 13% | 12% | 8% |

N = 4906, Source: Ipsos consumer survey (2019)
3.6 The environmental perspective

There are important environmental impacts associated with chargers. The production of each charger (EPS and cable) requires raw materials; their production and transport also generates CO\textsubscript{2} emissions. When chargers are no longer used, they generate electronic waste. The higher the number of chargers produced, used, and eventually discarded, the more significant these impacts are, similarly as they become more complex and heavier. These environmental concerns were considered a serious issue by 72% of the EU citizens who took part in the Public Consultation on mobile phone chargers. Furthermore, respondents overwhelmingly felt that chargers are often not properly recycled or reused, but simply thrown away or left in drawers. In this section we set out the key environmental impacts of the current situation in terms of material use, emissions and waste.

Material composition and usage of chargers

Understanding the material composition of a charger, i.e. which materials are used, in which proportions and from which sources (primary or recycled materials), is crucial to understanding the nature and scale of the environmental impacts of the current situation, as well as those associated with different policy options.

The 2014 RPA study did not investigate the material composition of chargers in detail. It estimated material savings on the basis of an average charger weight of 60g derived from weighing various models. In addition, an assumption was made that around 30% of the content of a charger was from recycled materials. There was no specification of material types.

To account for changes in chargers and improved information since 2014 we have carried out a new review of the available Life Cycle Analysis and other literature and discussed this issue with experts to build up an improved picture of charger composition. Important aspects to note from the review are:

1. There is relatively little information on chargers. Most relevant LCA studies focus on smartphones as a whole, often neglecting to include or disaggregate the charger-related impacts.

2. The difference in composition, weight and impact between different charger types appears to be small. This is especially the case for different cables and connectors (USB micro-B / USB C / Lightning) where there seems to be little tangible difference in the volume and type of materials used.

3. The largest part of environmental impacts are tied to the EPS, not the cable – due to the higher weight and value of materials used.

In relation to point 3 above, Life-Cycle Assessments generally conclude that the EPS has a significantly higher environmental impact than the cable, mainly due to its greater weight.\textsuperscript{21} The LCA conducted by the SustainablySMART project assessed impacts in terms of Global Warming Potential (GWP), abiotic depletion (ADP) of elements, abiotic depletion of fossil fuels, human toxicity potential (HAT) and terrestrial eco-toxicity potential (TETP). The figure below shows

the relative impacts of the smartphone, EPS (AC adapter) and cable, as a share of total impacts per category. This demonstrates the relatively low impact of chargers, and within this, the cable compared to the EPS.

Figure 16: Share of environmental impacts for smartphones and chargers, split by component

Specific information on the material composition of chargers is not widely available. It is clear that plastics in the casing of both the EPS and cable contribute a large part of the weight of a charger, but also that metals and other materials are also used, for example copper in the cable wires, and other metals in the plug pins and connectors. The most specific information we found was based on a disassembly analysis of a Samsung fast charger conducted by Fraunhofer IZM, which detailed the main materials contained in the EPS (charging block) and cable as shown in Table 10 below.

Table 10: Material composition of a Samsung fast charger

<table>
<thead>
<tr>
<th>Material</th>
<th>Contained in the EPS (weight in grams)</th>
<th>Contained in the cable (weight in grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastics</td>
<td>19.74</td>
<td>10.20</td>
</tr>
<tr>
<td>Copper</td>
<td>0.47</td>
<td>3.22</td>
</tr>
<tr>
<td>Steel</td>
<td>0.75</td>
<td>6.98</td>
</tr>
<tr>
<td>Ferrite</td>
<td>6.37</td>
<td></td>
</tr>
<tr>
<td>Aluminium²³</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>Unspecified²⁴</td>
<td>9.06</td>
<td></td>
</tr>
<tr>
<td>Total weight</td>
<td>38.08</td>
<td>20.40</td>
</tr>
</tbody>
</table>

Source: Adapted from an unpublished disassembly analysis performed by Fraunhofer IZM in the framework of the SustainablySMART project

²² Provided to the study team by the Horizon 2020 project SustainablySMART
²³ It was assumed that the electrolytic capacitors, which weigh in total 3.4g, are made up of 50% aluminium.
²⁴ Materials contained in some components of the circuit board and transformer.
Based on the SustainablySMART study, other sources and weighing of a selection of other charger types we constructed a material composition profile for each mobile phone charger component type. This specified its composition in terms of the weight of plastics, copper and other materials. These are as follows:

Table 11: Material composition profiles of charger component types

<table>
<thead>
<tr>
<th>Charger component</th>
<th>Types</th>
<th>Weight [g]</th>
<th>Of which: Plastic [g]</th>
<th>Copper [g]</th>
<th>Other [g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPS - USB A</td>
<td>USB A - Standard charger</td>
<td>32.2</td>
<td>16.7</td>
<td>0.4</td>
<td>15.1</td>
</tr>
<tr>
<td>EPS - USB A</td>
<td>USB A - Fast charger - USB-PD</td>
<td>67.4</td>
<td>34.9</td>
<td>0.8</td>
<td>31.6</td>
</tr>
<tr>
<td>EPS - USB A</td>
<td>USB A - Fast charger - QuickCharge</td>
<td>48.4</td>
<td>25.1</td>
<td>0.6</td>
<td>22.7</td>
</tr>
<tr>
<td>EPS - USB C</td>
<td>USB C - Standard charger</td>
<td>35.0</td>
<td>18.1</td>
<td>0.4</td>
<td>16.4</td>
</tr>
<tr>
<td>EPS - USB C</td>
<td>USB C - Fast charger - USB-PD</td>
<td>56.3</td>
<td>29.2</td>
<td>0.7</td>
<td>26.4</td>
</tr>
<tr>
<td>EPS - USB C</td>
<td>USB C - Fast charger - QuickCharge</td>
<td>52.0</td>
<td>27.0</td>
<td>0.6</td>
<td>24.4</td>
</tr>
<tr>
<td>Cables (1m)</td>
<td>USB A - USB Micro B</td>
<td>17.6</td>
<td>8.8</td>
<td>2.8</td>
<td>6.0</td>
</tr>
<tr>
<td>Cables (1m)</td>
<td>USB A - USB C</td>
<td>25.0</td>
<td>12.5</td>
<td>3.9</td>
<td>8.6</td>
</tr>
<tr>
<td>Cables (1m)</td>
<td>USB A - proprietary</td>
<td>15.8</td>
<td>7.9</td>
<td>2.5</td>
<td>5.4</td>
</tr>
<tr>
<td>Cables (1m)</td>
<td>USB C - USB Micro B</td>
<td>21.3</td>
<td>10.7</td>
<td>3.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Cables (1m)</td>
<td>USB C - USB C</td>
<td>25.0</td>
<td>12.5</td>
<td>3.9</td>
<td>8.6</td>
</tr>
<tr>
<td>Cables (1m)</td>
<td>USB C - proprietary</td>
<td>20.4</td>
<td>10.2</td>
<td>3.2</td>
<td>7.0</td>
</tr>
<tr>
<td>Adapter</td>
<td>Adapter USB Micro B - USB C</td>
<td>2</td>
<td>1.0</td>
<td>0.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Adapter</td>
<td>Adapter Proprietary - USB Micro B</td>
<td>2</td>
<td>1.0</td>
<td>0.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Adapter</td>
<td>Adapter Proprietary - USB C</td>
<td>2</td>
<td>1.0</td>
<td>0.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Adapter</td>
<td>Adapter USB A-USB C</td>
<td>2</td>
<td>1.0</td>
<td>0.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Note: not all materials sub-values will sum exactly to weight due to rounding.

Source: own calculations based on multiple sources including CRA (2015), Ercan et al (2016), Charger Lab, Amazon.

Combining these profiles with the stock model allows for an estimation of the total material use associated with the chargers added to the market each year. The results for our baseline scenario are presented below. This shows an increasing trend in material consumption to 2022, from around 11,000 tonnes in 2018 to 15,900 tonnes in 2022 (+45%). This increase is driven by the trend towards fast charging EPS, these are heavier than older 'standard' EPS chargers. Indeed the average weight of a single charger is modelled to increase from 58g to 84g in this same period. The EPS accounts for around 67% of the materials in 2018, increasing to 71% by 2022. A small decline in all these trends is observed after 2022 as a trends towards lighter EPS, i.e. those with USB C ports rather than USB A, is modelled.
We note that a portion of the materials used to produce a charger may come from recycled sources, such that the actual environmental impact of material consumption may be lower than the values presented above. The RPA study assumed that chargers consisted of 30% recycled content, on average, hence the raw material requirement represented 70% of a charger's weight. However, the percentage might not be representative and appears to refer only to the plastics component. In relation to this point we note that the vast majority of chargers in the EU are manufactured outside of the EU (primarily China) where recycling rules and targets are not as strict as in the EU. In the past there was the chance that some share of the material content of chargers may have been sourced from waste materials treated in the EU and sent to China for recycling. No robust data for this has been found in this work. Furthermore, policy changes in China announced in 2018 have seriously curtailed its import of waste materials such as plastics, low grade copper scrap and other materials for recycling. As a result, we believe that there is no significant circularity in materials recovered in the EU being recycled for use in new charger production in China. Nonetheless, recycling volumes for the EU remain important, and are addressed in the following sub-sections.

Electronic waste (e-waste) generation

The end-of-life phase of chargers requires their disposal as electronic waste (e-waste) regulated by the Waste on Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU). This Directive has set targets for the collection rate of different e-waste types; in the IT and telecommunications equipment category, in which chargers would typically be included, a target

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26 The assumption is based on a news article announcing the launch of "a line of phone chargers with housings made of at least 30 percent post-consumer plastics". Environmental Leader (2012) AT&T Launches Low-Energy, Recycled Content Chargers, available at: https://www.environmentalleader.com/2012/09/att-launches-low-energy-recycled-content-chargers/

for waste collection of 45% in 2016 and 65% in 2019 is set. As of 2016, an EU-wide rate of 56% was being achieved. It has also set targets relating to how this collected waste is treated, stating that by 2018, 80% of materials should be recovered and by 2019, 80% should be re-used or recycled. In 2016, respective rates were 89.1% and 83.3% demonstrating that these targets have already been achieved. These figures demonstrate that in this category of e-waste significant efforts on recycling are being made. However, not all consumers dispose of their old charger as soon as they replace their phone, and not all discarded chargers are properly recycled.

Further examination of data on how and when chargers are disposed found only limited information. Among the relevant data, a study based on a survey of 150 inhabitants of the city of Oulu, Finland in 2013 found that 55% of respondents had two or more unused mobile phones at home, demonstrating that chargers are often kept for extended periods when not in use and before being disposed of. Pointing to a potentially long delay of e-waste following phone purchase.

We investigated different aspects of this issue through the consumer survey, asking respondents a specific question on their mobile phone charger disposal methods. The responses suggested that most chargers are either in use by the original owner or others (30%), or are retained by users (41%). Of the 25% actually disposed, around 19% are recycled and 6% are disposed of (incorrectly) as general waste. Similarly within the consumer survey, questions were asked which distinguished between charger ownership and chargers in use, with average values of 3.2 and 1.8, respectively, indicating around 1.4 chargers per person are on average kept at home unused. These would not be considered e-waste until eventually disposed.

Table 12: Consumer survey response, charger disposal

<table>
<thead>
<tr>
<th>D3. How do you usually dispose of mobile phone chargers you are no longer using?</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>I still use all my old mobile phone chargers</td>
<td>14%</td>
</tr>
<tr>
<td>I pass them on to friends or family members</td>
<td>12%</td>
</tr>
<tr>
<td>I sell them online</td>
<td>4%</td>
</tr>
<tr>
<td>I usually keep them in my house</td>
<td>41%</td>
</tr>
<tr>
<td>I recycle them</td>
<td>19%</td>
</tr>
<tr>
<td>I throw them into my general-purpose rubbish bin</td>
<td>6%</td>
</tr>
<tr>
<td>99. Don't know</td>
<td>3%</td>
</tr>
</tbody>
</table>

\( N = 5,002 \), Source: Ipsos consumer survey (2019)

Taking these factors into account we have calculated e-waste volumes on the basis of the charger weight profiles (see Table 11) multiplied by estimated disposals from the stock of chargers in a given year after purchase, Table 5 explains in more detail the assumptions on disposal. The main part of this is that our assumptions reflect a large number of chargers being stored, but eventually being disposed over the course of a 10 year lifecycle.

The results for e-waste generation in the baseline scenario are presented below and show that between 2020 and 2028 average e-waste generation is around 11,000-13,000 tonnes per year. In the first part of the period there is a slight decline, reflecting the overall decline in charger (mobile phone) sales from 2008-2018, and an increase from 2023 onwards reflecting the modelled stabilisation of sales and increase in average weight of chargers. In terms of overall e-waste

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volumes in the EU, 12,000 tonnes represents only 0.3% of total WEEE collection in 2016 of 4.5 million tonnes, and 1.8% of the 670,000 tonnes of total IT and telecommunications waste equipment collection.

Figure 18: E-waste generation of chargers disposed each year in the baseline scenario, by material [tonnes], 2020-2028

Total e-waste generated by type [tonnes]

![Graph showing e-waste generation](image)

Note: As the stock model only models charger additions since 2008, e-waste generation does not include all earlier years of disposals until 2020, therefore the years prior to 2020 have been left out of the figure to show only results fully comparable over time.

Source: Stock model

Recycling of materials

Recycling of materials from disposed chargers can mitigate the environmental impact of the materials originally used. However, as noted previously, the recycled materials recovered from chargers in the EU are not expected to be used in new chargers due to restrictions on the import of waste materials for recycling by China, the main charger manufacturing country. Nevertheless collected e-waste materials can still find alternative uses in the EU secondary raw materials markets or in other export destinations. There are three key factors in estimating recycling volumes, (1) the recyclability of the materials found in chargers; (2) the volume of chargers disposed and the method of disposal; (3) the way in which disposed chargers are treated.

Addressing the first point, the LCA study on chargers performed by Fraunhofer IZM\(^3\) assumes that the two recyclable materials are plastic (Polycarbonates) and copper. Assuming a recovery rate of 84% for plastic and 92% for copper, the authors estimate that 16.59 g of plastic and 0.43 g of copper can potentially be recycled from a charger. However, this is a potential, rather than an actual value. An alternative study by Horta Ardun et al.\(^3\) estimated that the quantity of potentially recyclable materials in 1kg of mobile chargers amounts to 39%, based on a sample charger (model not specified). The main recyclable material is copper (27%), followed by plastics (polyethylene and PVC, about 5% each).

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\(^{30}\) SustainablySMART (2019) Regulation of Common Chargers for Smartphones and other Compatible Devices: Screening Life Cycle Assessment

According to the authors, silver, nickel, gold, palladium, and lead can also be recycled, but the recyclable quantities of these materials are very small. The potentially recyclable metals represent only 26% of the total weight of the printed circuit board. The authors note that polycarbonate makes up 42.3% of the charger weight, and at the time of this paper there was no recycling channel in France (home country of the authors) for this type of plastic originating from WEEE.

The second point is addressed by the assumptions in the stock model, which make use of the information from the consumer survey and other sources (see Table 5 for more details).

On the third point, the 2014 RPA study estimated a 4% recycling rate of old chargers, assuming the recycling rate of chargers is similar to the recycling rate of mobile phones, as estimated in a survey from Australia. The WEEE statistics referred to at the start of the previous section, indicate that collection and subsequent recycling rates are now considerably higher in the category of IT and telecommunications equipment. Based on collection rates of 56% and recycling rates of this material of 83%, an overall recycling rate of around 47% could be estimated in 2016.

Based on continuing improvements in these rates and recycling systems, as well as the consumer survey feedback, we modelled a recycling rate of 75% and incorrect disposal (to general waste) rate of 25% in 2019. These ratios were applied to all materials and modelled to evolve over time, with the recycling rate increasing by 1% per year to 2028, but also having increased to 75% in 2019 at the same rate from a lower level in 2008. The results for the baseline scenario are presented below in Figure 19. This shows recycling volumes of between 8,700 - 10,000 tonnes between 2020 and 2028, with similar trends and drivers as described for Figure 28.

Figure 19: Recycling of e-waste each year in the baseline scenario, by material [tonnes], 2014-2028

Note: As the stock model only models charger additions since 2008, e-waste generation does not include all earlier years of disposals until 2020, therefore the years prior to 2020 have been left out of the figure to show only results fully comparable over time.

Source: Stock model

32 RPA (2014) Study on the Impact of the MoU on Harmonisation of Chargers for Mobile Telephones and to Assess Possible Future Options
CO₂ emissions and other environmental impacts

The other key environmental impact associated with chargers is the greenhouse has (GHG) emissions of a charger. These are assessed over the full lifecycle, from material extraction, manufacturing, transport, use and disposal. As for other impacts, only a limited number of relevant assessments can be identified for the GHG emissions impact of chargers. The results of those identified in this work are presented below in Table 13.

Table 13: LCA estimates of embedded CO₂ emissions in chargers

<table>
<thead>
<tr>
<th>Life-Cycle Phase</th>
<th>Source &amp; charger model</th>
<th>EPS</th>
<th>Cable</th>
<th>Total charger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material acquisition</td>
<td>Ercan (2013) - Sony Xperia T</td>
<td>1.18</td>
<td>0.301</td>
<td>1.48</td>
</tr>
<tr>
<td></td>
<td>Manufacturing</td>
<td>0.249</td>
<td>0.0432</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td>SustainablySMART (2019) - Samsung fast charger (EP-TA20EWE)</td>
<td>0.898</td>
<td>0.096</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>Charles River Associates (2015) - Apple charger (UK plug)</td>
<td>1.85</td>
<td>0.35</td>
<td>2.20</td>
</tr>
<tr>
<td>Transport</td>
<td>Ercan (2013) - Sony Xperia T</td>
<td>0.1729 (transport within China)</td>
<td>0.0692 (transport within China)</td>
<td>0.24 (transport within China)</td>
</tr>
<tr>
<td></td>
<td>Charles River Associates (2015) - Apple charger (UK plug)</td>
<td>0.011</td>
<td>0.005</td>
<td>0.016</td>
</tr>
</tbody>
</table>


These studies were analysed and averages calculated for the impact per g for the charger being evaluated in each study as shown in Table 14. These values were used as the basis to calculate the CO₂ emissions impact per charger component (EPS or cable) in proportion to the estimated weight of the relevant component. An example is presented in the table which shows a total impact of 3.34kg CO₂e for this charger. Key observations are that the largest part of the impact is attributable to the EPS which in comparison to the cable is both heavier and has more complex components, each of which contribute to higher emissions.

34 Weight: 60g EPS, 24g cable
35 Weight: 38g EPS, 20g cable
36 Weight: 28.6g EPS, 17.6g cable
Table 14: GWP impact assumptions for charger components and example for single charger

<table>
<thead>
<tr>
<th></th>
<th>Average GWP (kg CO₂e) per g weight of component</th>
<th>Average GWP (kg CO₂e) of Samsung fast charger (EPS 38g, cable 20g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EPS</td>
<td>Cable</td>
</tr>
<tr>
<td>Raw material acquisition and manufacturing</td>
<td>0.044</td>
<td>0.012</td>
</tr>
<tr>
<td>Transport</td>
<td>0.027</td>
<td>0.018</td>
</tr>
<tr>
<td>End of life</td>
<td>0.0003</td>
<td>0.0002</td>
</tr>
<tr>
<td>Total</td>
<td>0.0713</td>
<td>0.0302</td>
</tr>
</tbody>
</table>

Based on the different charger weight profiles and the annual sales, the stock model is used to calculate total lifecycle CO₂ emissions. The emissions for the baseline scenario are shown below in Figure 20, this shows that associated emissions increase from around 636kt CO₂e in 2018 to a peak of around 950kt CO₂e by 2022, before easing to 899kt CO₂e by 2024. The main driver of this being the growth of fast charging EPS, which are assumed to be heavier than current 'standard' EPS. It should be noted that more than half of these emissions are attributed to raw material acquisition and manufacturing and therefore will be accounted in China and other manufacturing countries.

Figure 20: Life cycle CO₂ emissions for charger additions in the baseline scenario, by component [kt CO₂e], 2014-2028

ktCO₂e emissions

Source: Stock model

Noting that all emissions are accounted in the year of purchase, not over a hypothetical life cycle period.
3.7 The perspective of economic operators

During the interviews conducted, industry representatives from across different sectors (industry associations, mobile phone manufacturers, charger manufacturers, and distributors) and standardisation bodies shared their views on the current situation of mobile phone chargers and their interoperability. Overall, interviewees agreed that the MoU was effective at harmonising charging solutions towards USB micro-B and, although they agreed that this transition would have happened regardless, the MoU boosted this move.

When asked about the current situation, interviewees were divided between those who consider that the market is already harmonised and there is not a problem that needs to be addressed (a majority), and those who thought proprietary solutions should not be allowed in the future (a minority). Interviewees' comments on the different components of the charger are briefly summarised below.

External Power Supply

According to most interviewees, EPS are currently very harmonised, since EPS that are compliant with relevant standards are backwards and forwards compatible, which means that consumers can charge their phones with their old chargers, and vice-versa. There was a general belief amongst those interviewed that manufacturers using proprietary solutions are gradually and naturally transitioning towards standardised solutions as specifications are published and updated. Despite this natural transition, most industry representatives were opposed to mandating for certain standards, such as the IEC 62680 series (although a minority were in favour). Reasons against "forced" harmonisation include:

- It would send the "wrong" signal for manufacturers that complied with IEC 62684, which would not be valid any longer in the EU;
- The difficulty of controlling suppliers' compliance with standards by both public authorities and manufacturers of mobile phones, and risk of having more sub-standard and/or counterfeit chargers in the market;
- The difference in cost between EPS using USB PD and "standard EPS" (compliant with IEC 62684)\(^{38}\);
- Design limitations that such a regulation would impose. Fast charging (via USB PD) produces more heat, which limits battery life. According to some interviewees, industry should be able to design the charger that provides the best trade-off between fast charging and battery life.

Industry representatives were also asked about the possibility of mandating for a more restricted EPS with, for instance, specific voltage and current levels to charge all phones and, potentially, other devices. Industry seemed particularly concerned when considering this option, and raised that it could lead to sub-optimal outcomes, since different devices frequently have different charging profiles.

Connectors on the EPS

Industry representatives were very positive on the impact of the 2009 MoU on the harmonisation of the connector on the EPS end, a situation that has been maintained to date. There are no longer any phones with EPS with captive cables and, until very recently, all EPS had a USB Type-A connector. Most recently, however, some EPS included in the box with high-

\(^{38}\) For more information on the difference in cost between different charging technologies, see section 5.4
end phones have a USB Type-C connector. All interviewees (including also non-industry stakeholders) agreed that mandating for the use of USB Type-C only at the EPS end would be detrimental for consumers and the environment, given the current existing infrastructure for USB Type-A. In addition, EPS with USB Type-C connectors have a higher cost that EPS with USB Type-A connectors.35

Connectors on the device

The connector on the device is the element of the charger where there is currently most fragmentation. Three main solutions co-exist, which are not interoperable with each other (unless an adaptor is included): USB micro-B, USB Type-C, and Lightning. In addition, whereas for the other elements there was consensus amongst the industry that there is a low degree of fragmentation (i.e. there is no problem that needs to be addressed, and that regulation is not needed to achieve further harmonisation), in the case of the connector on the device, some interviewees considered regulation is the only possible way to achieve harmonisation. Most interviewees considered that mandating for USB Type-C would not have major implications for their companies if sufficient transition time is allowed, since they are moving towards USB Type-C anyway. However, one manufacturer claimed that their proprietary connector is better suited to charge their phones, and that using USB Type-C instead would require profound changes in the design of their phones (mainly due to the bigger size of USB Type-C connectors compared to their proprietary solution). They argued that in those devices for which USB Type-C is a better option than their proprietary solution, they have already made the shift to USB Type-C.

Innovation

One of the main arguments expressed by industry representatives against regulation of any sort (i.e. affecting any of the components described above) is its potential impact on innovation. Obligatory regulation (vs. a voluntary approach), they warn, may decrease investment flows towards R&D projects developing new charging solutions, since mobile manufacturers would not be able to implement any new technology, even if it provided significant advantages over the existing one. In their view, the fact that a new regulation may include provisions to shift towards new (common) charging methods does not solve this issue, since:

1. There is a possibility that new charging technologies are not developed, or are developed at a slower pace, since the incentives for individual companies to invest in developing solutions to provide them with a competitive advantage would be reduced.

2. Even if a new technology was available, it normally takes time to develop the standard. And if this was the case, the company that developed such a technology could not obtain royalties once it is standardised.

As an example of how proprietary charging solutions can contribute to the development of new common solutions and standards, a few interviewees commented on the influence of Lightning on the development of USB Type-C. According to several interviewees, for example the fact that USB Type-C is reversible is in part due to the existence of Lightning, which already incorporated this feature.

Industry representatives provided other examples of innovations happening due to the competitive landscape (lack of regulation towards a standard solution), such as the technological developments in memory cards:

Example: Memory Cards

While it is inherently impossible to predict future innovations that may be impacted by imposing constraints on mobile phone connectors, an instructive example of innovation in the absence of enforced harmonisation is provided by flash memory cards. The format of flash memory cards has developed significantly with the evolution of digital cameras. Designs of memory cards have included: the Sony Memory Stick, CF cards, SD card, mini SD, Micro SD, and others. While it might be seen as inconvenient that, with every new camera purchased, a consumer may have required a new card type, the lack of a prescribed interface led to a competitive race to become the most widely used standard, which in turn led to rapid technological improvements. Adaptors facilitated interoperability between interface generations and, over time, the cards have become smaller as a result of the innovation spurred by competition, using fewer resources and allowing for smaller interfaces on the product side. – Mobile manufacturer representative

Some of the industry representatives’ concerns about the impact that regulation may have on innovation were shared by other stakeholders to a certain extent. A consumer representative, for instance, commented on the intrinsic risk that a regulation may preclude the arrival of a better future connector, which could be more convenient and easy to use for people with disabilities. This interviewee suggested as an example the possibility to have magnetic connectors, which is a technology that Apple included in previous versions of their MacBook, but has now been replaced by USB Type-C.

3.8 Illicit markets

There is a shared concern among industry and other stakeholder groups who believe that a significant and growing share of the stand-alone mobile phone chargers that are being sold (primarily online) is counterfeit. While this is difficult to substantiate with objectively verifiable data, comments and discussions about problems with non-genuine chargers (and/or advice on how to identify genuine ones) abound in online fora. The often very significant price differences between ostensibly identical branded chargers on online retail portals, compared with major phone manufacturers’ own online shops, raise further doubts as to whether the former are all genuine. According to one report, Apple found in 2016 that 90% of Apple chargers and cables labelled as genuine on Amazon.com were counterfeit.40

In the absence of reliable data on the illicit market for counterfeit chargers, statistics compiled by the European Commission on the enforcement of intellectual property rights (IPR) by EU customs authorities may at least provide a sense of the likely scale of the problem. According to the latest report,41 of the nearly 75,000 procedures that were associated with the over 57,000 cases of detentions of counterfeit goods at the EU borders in 2017, 2,582 (or 3.5%) were of "parts and technical accessories for mobile phones" (product category 6b). A total of over 770,000 products in this category were seized, with a domestic retail value (based on the retail price at which the goods would have been sold had they been genuine) of over €16 million (the ninth highest among the 36 product categories recorded). The countries of provenance of over 99% of these products were Hong Kong and China. It is worth noting that the number of procedures concerning parts and technical accessories for mobile phones in 2017 was lower than it had been in all three previous years (with a peak of nearly 5,000 in 2015). Unfortunately, on request, the Commission was unable to provide more detailed data (or estimates) of the proportion of these figures that relate specifically to chargers (as opposed to other

40 URL: https://www.telegraph.co.uk/technology/2016/10/20/apple-finds-90-of-its-chargers-and-cables-on-amazon-are-fake/
41 European Commission (2018): Report on the EU customs enforcement of intellectual property rights: Results at the EU border, 2017
mobile phone parts or accessories). It is also important to emphasise that the figures only relate to counterfeit goods that were detained at the EU border, not the (potentially much higher) numbers that went undetected.

The existence of a significant market for counterfeit chargers raises serious concerns, in terms of the direct (foregone sales) and/or indirect (e.g. due to a negative effect on their brand reputation) economic losses to the holders of the intellectual property rights (usually the large mobile phone manufacturers themselves), as well as in terms of product safety for users (see below). Industry representatives in particular tended to argue that the situation could potentially be exacerbated further with the introduction of a single common charger, in so far as this could increase the demand for (frequently counterfeit) stand-alone chargers, as well as simplify the production chain for chargers, and therefore facilitate the production of counterfeit chargers.

3.9 Product safety

Product safety is an important issue for chargers. Serious safety issues for chargers most often relate to electric shock, electrocution and fire risks from poorly designed and manufactured chargers. These problems primarily affect the EPS. The assessment here is based on desk review and interviews with national authorities and a safety organisation.

The issue primarily affects standalone charger sales, as chargers supplied with phones are tested by manufacturers and well matched to their devices. Whilst there are a number of suppliers of good quality standalone chargers (such as Belkin, Anker, etc.), there are also many more products where the quality and compliance with safety standards is not guaranteed. These products can be from minor, less well-known brands, or unbranded. Counterfeit products are also an issue, with imitations of (especially) Apple but also other major brands not being manufactured to the same standards. The 2014 assessment flagged safety as a particular issue for standalone chargers, noting ‘that as much as 30-60% of the standalone charger market may not comply with applicable technical standards, some of which relate to safety’. This being in large part attributable to chargers produced by non-OEM firms, which were often, but not always, counterfeits. A contributory factor is also the growth in online purchases sent direct to consumers which are more difficult to regulate and where counterfeit products are more common.

Among the EU citizens that participated in the Public Consultation on mobile phone chargers, 31% were concerned by the consequences of the current situation in terms of safety. The majority of these agreed that chargers which are unbranded or not of the same brand, and/or not designed for the specific mobile phone, are potentially unsafe, and also that there are many counterfeit chargers which are potentially unsafe. 31% of consumer survey respondents also reported that a charger had become unsafe to use within the last 24 months, pointing to a not insignificant problem with product safety.

RAPEX

The results of an analysis of the number of risk alerts (serious product risks or other risks) for mobile phone chargers between 2014 and part of 2019 from RAPEX, indicates that there is an increasing trend in the detection of phone chargers that pose risks to consumers (see Figure 21 below). Most of the alerts were submitted for standard mobile phone chargers. The following items were out of scope: laptop chargers, chargers specific for other devices (game consoles, LED lights, e-cigarettes, etc.), socket adaptors for multiple regions, car power adaptors for devices in general, USB stand-alone cables and power banks.

42 RAPEX is the EU rapid alert system for dangerous non-food products. The analysis included alerts for products with serious risks or other risks, in the category 'Electrical appliances and equipment' up to the end of May, 2019. Further filtering was carried out to include only alerts specific to mobile phone chargers. The following items were out of scope: laptop chargers, chargers specific for other devices (game consoles, LED lights, e-cigarettes, etc.), socket adaptors for multiple regions, car power adaptors for devices in general, USB stand-alone cables and power banks.
changers, although in recent years risk alerts for fast chargers and wireless chargers have started to appear as well. The numbers for chargers represent between 5-25% of the total RAPEX alerts in the category Electrical appliances and equipment, where an increasing trend is becoming evident, highlighting that chargers are becoming a more significant problem in the area of electrical equipment. These numbers compare to values recorded in the 2014 study for 2008-2013 of 67 in total, ranging from 7 to 16 per year. When compared to the values from 2014 onwards this points to an increasing trend43.

Figure 21: Number of risk alerts in the EU28 for mobile chargers from 2014 to 2019 by type of charger

More than 60% of the products with risk alerts analysed were original brands of chargers for phones or compatible devices (e.g. tablets) – see Figure 22. Almost a third of the alerts were chargers without a brand, while 11% of the alerts were counterfeit chargers pretending to pass for chargers of popular brands like Apple and Samsung. Counterfeit products pose an important safety threat, and are an issue that is increasing in general. The latest EC reports on this issue highlight mobile phone chargers and accessories that are bought online and shipped direct to consumers44. Other independent reports also highlight the safety risks of counterfeit products, with a report by Electrical Safety First in the UK finding only 1 of 64 counterfeit Apple chargers passed all technical and safety tests45.

43 There may be some small differences in methodology applied between the 2014 study and this study.
From the RAPEX data, almost all the technical defects that triggered the risk alerts failed to comply with safety requirements of the Low Voltage Directive, due to one or more of the following technical defects:

- Insufficient clearance or creepage distance between the primary and secondary parts of the transformer and the circuits, which could lead to the user receiving an electric shock;
- Lack of additional fixing of the soldered connections of the primary circuits. If a wire disconnects, the creepage distances and clearances of the reinforced insulation may be reduced;
- Inadequate electrical insulation and/or housing that is not sufficiently resistant to heat or breaking, as a result live parts could become accessible to the user and cause an electric shock, burns and a fire;
- Poor product design, that does not withstand foreseeable electric current overloads, leading to the overheating of components with the risk fire.

ICSMS

The Information and Communication System on Market Surveillance (ICSMS) is another database used to exchange and store information on inspection findings. In the case of the ICSMS, market surveillance bodies make use of the platform on a voluntary basis. A search for “charger” products between 2009 to 2019 in the platform resulted in 244 product safety risk alerts; on average over this period, 38% of these referred specifically to mobile phone chargers, while the rest belong to other type of chargers not specific to mobile phones (see Figure 23 below). Other / out of scope charger products include laptop chargers, chargers specific for other devices (game consoles, LED lights, e-cigarettes, etc.), socket adaptors for multiple regions, car power adaptors for devices in general, USB stand-alone cables and power banks.

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46 Only one case was found where the product did not have the risk of electric shock or causing a fire. The technical defect of the product was instead the presence of restricted hazardous substances (ROHS 2), therefore it was non-compliant with the Electronic Waste Directive.
47 The analysis included alerts for products that included the key word “charger” up to the end of July, 2019.
48 Other / out of scope charger products include laptop chargers, chargers specific for other devices (game consoles, LED lights, e-cigarettes, etc.), socket adaptors for multiple regions, car power adaptors for devices in general, USB stand-alone cables and power banks.
trend in alerts increased up to 2016, after which a significant decline is observed for 2017 and 2018. This trend is somewhat, but not fully, consistent with the alerts reported in RAPEX. Almost all alerts are for standard phone chargers, although in 2018 there was one alert for wireless charger and one for fast charger (USB-Type C).

Overall, the RAPEX and ICSMS data, supported by feedback from authorities, suggests that there are problems with charger products and that these are increasing. At the same time, data in 2017-2018 does not strictly keep to this trend and therefore it will be interesting to see end results for 2019. It is difficult to draw strong conclusions on these trends and given the weaknesses and gaps in Market Surveillance across the EU and due to other key variables changing over time, such as the available resources and focus on these products by the relevant authorities.

3.10 Summary

The 2009 MoU brokered by the European Commission helped to facilitate a profound change in the market for mobile phone chargers. The ensuing years saw a significant reduction in the fragmentation of charging solutions, the widespread adoption of the “common EPS” in accordance with the international standards developed based on the mandate from the Commission, and convergence of around three quarters of the market to USB micro-B connectors. However, the remainder of the market (essentially corresponding with Apple’s iPhones) continued to rely on proprietary connectors.

Footnotes:

It should be noted that there are considerable differences between the number of records from the 2014 study and this study for the years 2010-2013. The number of overall risk alerts resulting from a search with the same key word (charger) is on some cases higher (for years 2010, and 2013) or considerably lower (for years 2011 and 2012 only 1 and 2 alerts were found, respectively), even though no further filtering was applied in this study. This could be explained by the addition or removal of records in the ICSMS platform after the analysis of the 2014 study was carried out.
The years since the definitive expiry of the MoU in 2014 have seen profound technological changes as well as significant shifts on the market for mobile phones (and to some extent, for other portable electronic devices with similar charging profiles, which includes tablets, e-readers, cameras and wearables, but not laptops). Some new / emerging technologies appear to be on a pathway to becoming dominant in the next few years, in particular the gradual replacement of USB micro-B by the more advanced USB Type-C connectors (which were already used in nearly three out of ten phones sold in the EU in 2018), and the apparent trend towards fast charging solutions based on (or compatible with) USB Power Delivery (PD). Another technological innovation, wireless charging, is still very incipient, and the market shows no clear signs of converging towards a specific technology yet. Attempts to reach a new voluntary agreement to address the remaining fragmentation of the charging solutions for mobile phones, taking into account the current state of technology, have so far failed to reach a conclusion that the European Commission and many stakeholders would consider satisfactory.

Thus, in summary, the current situation can be characterised as follows:

- Absence of any binding (voluntary or regulatory) requirements as regards chargers for either mobile phones or other portable electronic devices.
- A high but not universal degree of interoperability of different charging solutions, due to the fact that cables are almost always detachable from the EPS, and that large parts of the market have adopted technologies (including connectors) based on USB specifications and standards.
- Potentially significant variations in charging performance between brands and devices, due to the wide range of fast charging solutions on the market, meaning that, even if the likelihood is high that any given modern EPS can be used to charge nearly all mobile phones that are currently on the market, it may not do so at the same speed.
- A market in constant evolution, with USB Type-C connectors expected to gradually replace legacy USB connectors at the phone end (within the next few years) as well as the EPS end (more slowly), and innovation in fast and wireless charging technology likely to continue at a rapid pace.

The available evidence points to two main problems that arise from this situation:

- **Consumer inconvenience**: According to our survey of a broadly representative panel of consumers in ten EU Member States, most mobile phone users (84% of all respondents) have experienced one or more of a series of problems related to their phone chargers in the last two years. Commonly cited problems (each experienced by between one third and half of respondents) were the inability to charge certain devices (as fast) with certain chargers; having too many chargers taking up space in the home and/or workplace; situations where they needed to charge their phone, but the available chargers were incompatible with it; and confusion about which charger works with what device. Although the majority of those who reported having experienced each of these problems did not feel they were particularly serious, this still leaves around 15% to 20% of all survey respondents who reported one or more of these problems had caused them significant issues.
• **Negative environmental effects.** The production of each charger requires raw materials; their production and transport also generates CO₂ emissions. When chargers are no longer used, they generate electronic waste. The higher the number of chargers produced, used, and eventually discarded – and the more complex and heavier they are – the more significant these impacts. Based on our stock model, we estimate an increasing trend in material consumption, from around 11,000 tonnes in 2018 to 16,000 tonnes in 2024; an average e-waste generation of around 12,000 tonnes per year (around 75% of which is recycled); and associated life cycle emissions of around 600 to 700 kt CO₂e per year, which is likely to increase due to the growth of fast charging (and therefore heavier) EPS.

The main objective of the initiative to create a common charger for mobile phones (and potentially also other portable electronic devices) is to address these problems, while avoiding unintended negative effects, in particular the following:

• **Innovation:** The industry (mobile phone manufacturers and other digital industry sectors) are concerned that mandating for a certain type of phone charger would constrain future innovation in the field of charging technology and potentially also other aspects of phones / devices, as it would risk “locking” the industry into a certain technology for longer than would be ideal from the perspective of both economic operators and consumers, and also reduce the incentives for companies to invest in the research and development of new technologies, as the opportunities to use these to gain a competitive advantage would be limited.

• **Illicit markets and product safety:** There appears to be a substantial market for counterfeit chargers, which raises concerns in terms of the direct and/or indirect economic losses to the holders of the intellectual property rights (usually the large mobile phone manufacturers themselves), as well as in terms of product safety for users (as substandard chargers – which do not necessarily have to be counterfeit – imply higher electric shock, electrocution and fire risks). As these issues are almost always associated with stand-alone chargers (which are very difficult to control effectively, especially if sold online), they could be exacerbated by the introduction of a single common charger, in so far as this could increase the demand for stand-alone chargers.
4 Policy options

This chapter presents the policy options for the potential new initiative on common chargers. It defines the baseline scenario, briefly discusses the various technical and legal elements that were considered and, following from this, provides the short-list of options that are assessed in-depth in the ensuing chapters.

4.1 The baseline

This study treats the new MoU proposed by the industry in 2018 (but not endorsed by the Commission) as the baseline (i.e. the "no policy change" scenario). As outlined previously (see section 3.1), the MoU’s signatories committed that, beginning no later than three years from the date of signing, any new smartphone models they introduce to the EU market will be chargeable through a USB Type-C connector or cable assembly. Three types of cable assemblies are considered compliant: (1) those that are terminated on both ends with a USB Type-C plug; (2) those that are terminated on one end with a USB Type-C plug and have a vendor-specific (i.e. proprietary) connect means (hardwired/captive or custom detachable) on the opposite end; and (3) those that sources power to a USB Type-C connector from a USB Type-A connector. For the sake of clarity, the table below summarises the connector combinations that are likely to follow from this in practice (taking into account that, based on the information at our disposal, it seems extremely unlikely that any manufacturer would introduce a proprietary solution at the EPS end in the foreseeable future).

Table 15: Types of connectors envisaged under the 2018 MoU

<table>
<thead>
<tr>
<th>Combination</th>
<th>Device end</th>
<th>EPS end</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combination 1</td>
<td>USB Type-C</td>
<td>USB Type-C</td>
</tr>
<tr>
<td>Combination 2</td>
<td>Proprietary</td>
<td>USB Type-C</td>
</tr>
<tr>
<td>Combination 3</td>
<td>USB Type-C</td>
<td>USB Type-A</td>
</tr>
</tbody>
</table>

Furthermore, as part of the baseline, we assume that adaptors from proprietary to USB Type-C connectors will continue to be available for purchase. Unlike its predecessor, the 2018 MoU does not contain a specific commitment in this regard; however, such adaptors are currently widely available on the market, and there is no reason to believe this would no longer be the case in the foreseeable future.

Our main assumptions regarding the evolution of the stock of mobile phone chargers in use, including the split between the different main types of chargers, is shown in section 3.3 above.

50 The 2009 MoU stipulated that, "if a manufacturer makes available an Adaptor from the Micro-USB connector of a Common EPS to a specific non-Micro-USB socket in the Mobile Phone, it shall constitute compliance" with the MoU. It defined an "Adaptor" as a device with a Micro-USB receptacle/plug connecting to a specific non Micro-USB connector. It clarified that an Adaptor can also be a cable.
4.2 Elements considered

When considering the idea of a "common" or "harmonised" charger for mobile phones and potentially other portable electronic devices, it is important to be as clear as possible about what is meant by this. As noted previously, charging solutions usually consist of several elements (in particular, a charging block or external power supply (EPS), and a cable assembly to connect the EPS to the device). Although the connectors on the device end of the cable tend to be the first issue that comes to mind when discussing a possible harmonisation initiative (and constitute the focus of the 2018 MoU), the other elements also merit consideration. The question of the scope of the possible initiative is also critically important to address, as is the policy instrument (voluntary or regulatory initiative). Below, we discuss each of the main elements in turn, considering the extent to which the current situation leads to problems and the feasibility of potential solutions, in order to define specific policy options where appropriate. Where this is not the case, we have discarded the element in question from the in-depth assessment, and outline our reasoning behind this.

Figure 24: Schematic overview of elements considered

Connectors on the device end

The current trend on the mobile phone market regarding the connectors on the device end is clear (see section 3.3): the USB micro-B connectors that formed the basis of the 2009 MoU, and were used in around 80% of mobile phones in 2016, are gradually being replaced with the newer USB C connectors. The market share of proprietary connectors (namely Apple's Lightning connectors) continues to be around 20%. In order to achieve further harmonisation of this element, the main option is a (mandatory or voluntary) commitment to USB C as the common solution. A further consideration is the possibility to allow those manufacturers who wish to continue to use proprietary solutions to make available adaptors.

The policy options we will take forward for in-depth analysis are:

- **USB Type-C as the only connector at the device end**, with no adaptors allowed
- **Compulsory adaptors in the box**: Manufacturers who wish to continue to use proprietary connectors (receptacles) in their mobile phones are obliged to include an adaptor in the box. There are two technical variations (sub-options) of this:
  - Optional adaptors in the box
  - Compulsory adaptors in the box
Manufacturers could be obliged to include a cable with a USB Type-C connector. Those who wish to continue to use proprietary (e.g. Lightning) receptacles in their phones would be obliged to provide an adaptor from USB Type-C to their proprietary receptacle in the box.

Manufacturers could be allowed to continue to provide cables with either a USB Type-C or a proprietary connector. Manufacturers that choose to provide a cable with a proprietary connector would be obliged to provide an adaptor that enables its use with a USB Type-C receptacle.

Connectors on the EPS end

It is worth considering whether there is a need for / added value in seeking to further harmonise the connectors on the EPS end, in order to ensure that cables are compatible with any EPS. The situation in this respect has evolved considerably since the 2009 MoU, when most charging solutions included captive cables. Today, all mobile phone chargers are sold with detachable cables, the vast majority with a USB Type-A connector on the EPS side. This is expected to gradually shift towards USB Type-C, but this process is much slower than at the device end, inter alia due to the existence of a large amount of USB Type-A sockets / infrastructure, not only in EPS but also in laptops, buildings, cars, public transport etc.

In light of this, we conclude there is no strong case for further harmonisation at the present time regarding the connectors on the EPS end. The level of harmonisation is already very high: all cables are detachable, and there are no proprietary solutions on the market, which ensures the interoperability of the cables with a wide range of EPS (in principle at least; for considerations regarding the EPS itself see below). It would be possible to define USB Type-C as the only solution at the EPS end. However, since the transition to this is under way already (albeit slowly), it seems very likely that the benefits of attempting to accelerate this transition "artificially" would be marginal, and would be outweighed by the costs, as a fast transition would risk making a significant amount of existing EPS, other devices (such as laptops, which can be connected to phones not only for the purpose of charging but also, and arguably more importantly, for data transfer) and charging infrastructure obsolete, with potential negative consequences and costs in terms of both consumers and e-waste.

Therefore, we will not include this element among the options to be assessed further. It may be worth considering whether any new initiative should seek to cement the status quo (i.e. detachable cables with either a USB Type-A or a USB Type-C connector at the EPS end), and thereby rule out any potential future fragmentation (though this appears very unlikely at present). However, in view of the available evidence, it appears far preferable to allow the transition from one common solution (USB Type-A) to the next common solution (USB Type-C) to proceed naturally, keeping pace with market developments and the evolution of consumer preferences.

External power supply

As noted previously (see section 3.6), the heavier part of mobile phone chargers, and therefore the one that accounts for most of the environmental impact, is not the cable but the EPS. As part of the 2009 MoU, the EPS was harmonised in accordance with standard IEC 62684 (first published in 2011, updated in 2018), which specifies the interoperability of common EPS for use with data-enabled mobile telephones. It is based on legacy USB technologies (in particular USB micro-B and the corresponding USB charging standards and specifications). It does not cover charging interfaces that implement IEC 62680-1-3 (which defines the USB Type-C receptacles, plug and cables), IEC 62680-1-2 (which defines the USB Power Delivery system) and IEC 63002 (which defines interoperability guidelines for EPS used with portable devices). It should be noted that IEC 63002 was adopted as a guidelines, rather than a standard as such, which means it is currently difficult to certify and/or enforce. This was reportedly due to the fact that at the time of its finalisation (2013-14), the first generation of USB PD and USB Type-C specifications had
computing devices that implement the former, ensuring the EPS and device can "communicate" with each other so that the EPS flexibly provides exactly the power the device requires.

Therefore, it is worth considering whether the potential new initiative should address the interoperability of the EPS, in order to ensure these are able to charge the widest possible range of mobile phones (and potentially other electronic devices). This could be achieved by laying down interoperability as an essential requirement, which would be concretised through technical specifications provided in formal standards. The development of a new standard for the EPS appears unnecessary, since today (unlike in 2009) relevant international standards already exist (see above). Based on the information at our disposal, most manufacturers voluntarily choose for their mobile phones and corresponding chargers to comply with the standards listed above, as it is typically in their own interest to ensure interoperability. Nonetheless, an explicit and enforceable commitment to these standards could potentially help guarantee their consistent application, and ensure any fast charging solutions that are used / developed are compatible with USB Type-C and/or USB PD.

In this context, another aspect to consider is the charging performance (i.e. speed). Fast charging is closely linked to the power provided to the device by the EPS. The power (expressed in watts) is a function of the current (expressed in amperes) and the voltage (expressed in volts). Whereas the most basic USB specification that was predominant at the time of the 2009 MoU only sent between 0.5 and 1 ampere (A) of current using 5 volts (V) for just 2.5 to 5 watts (W), modern fast charging technologies boost these figures, typically to provide 15W or more of power. Although fast charging technologies vary somewhat (see section 3.2), they all share a common theme: more power. In order to ensure EPS are not only interoperable with all phones, but are also guaranteed to provide the performance consumers increasingly come to expect, a future common EPS could therefore include minimum specifications in terms of power (as another essential requirement).

Therefore, the policy options we propose to take forward for in-depth analysis are:

- **Guaranteed interoperability of EPS**: This would entail a commitment (via a voluntary agreement or an essential requirement enshrined in regulation) to ensuring all EPS for mobile phones are interoperable. This would be concretised via reference to compliance with the standards IEC 62680-1-3 (USB Type-C, for chargers up to 15W) as well as IEC 62680-1-2 and IEC 63002 (USB PD, for chargers above 15W).

- **Interoperability plus minimum power requirements for EPS**: To facilitate adequate charging performance, all EPS for mobile phones would have to guarantee the provision of at least 15W of power (in line with most current fast charging technologies). To also ensure full interoperability, all EPS would have to be capable of "flexible power delivery" in accordance with common standards / specifications (which in practice would be concretised via reference to the USB PD standards IEC 62680-1-2 and IEC 63002).

only just been developed, and market adoption was still limited. Now that these specifications have been updated numerous times and adopted widely on the market, there are plans to revise IEC 63002, update it in view of the latest USB PD standard and safety standard, and incorporate more requirements to support interoperability.

52 It is worth noting that the 2009 MoU introduced the concept of the "preferred charging rate" (defined as charging a battery from 10% capacity to 90% capacity within a maximum of 6 hours). As part of this study, we have explored whether, instead of or in addition to defining minimum power requirements, a new initiative could include reference to an updated preferred (or minimum) charging rate. However, this was considered suboptimal, as (all other factors being equal) devices with a larger battery capacity take longer to fully charge their batteries. Therefore, according to industry representatives, the definition of an ambitious "preferred" or "minimum" charging rate would unfairly impact devices with larger battery capacities, potentially limiting the provision of high battery capacity devices for consumers.
Wireless charging

The emergence of wireless (inductive) charging solutions raises the question of whether such solutions should also be included within the scope of a possible harmonisation initiative. In principle, such an initiative could seek to define common standards and/or specifications that ensure all wireless chargers are interoperable with all mobile phones that are wireless-charging enabled, independently of the manufacturer.

However, as discussed previously (see section 3.2), wireless charging is a very incipient technology. At present, its energy efficiency and charging speed cannot match those of wired solutions, and there are no indications that wireless charging is likely to become the dominant solution, or even make wired charging obsolete, in the foreseeable future. Three main technologies for wireless charging currently co-exist; these are not mutually exclusive, and it is not yet clear which of these (if any) is technologically superior and may therefore become widely (or even universally) used across manufacturers.

Therefore, we will not include this element among the options to be assessed further. At the present time, it seems premature to attempt to seek a harmonised solution; the technology is too incipient, meaning there would be a high risk of prematurely selecting specific technologies, and thus curtailing further innovation and market development. Nor is there an obvious problem in this area, or a strong demand from consumers or stakeholders for a common wireless charger.

Product scope

Since its inception, the Commission’s initiative has focused on (data-enabled) mobile telephones. However, in view of the fact that chargers can potentially interwork with a variety of electronic and electrical equipment, this study was also tasked with providing an analysis of the “possible indirect impact on the EU market for other small portable electronic devices requiring similar charging capacity.” Therefore, as part of the assessment of the impacts of each option, we explore the extent to which its scope could be extended to other portable electronic devices, and provide an indication of the likely indirect impacts on these.

Our analysis of different categories of other devices confirms that there is a range of devices with charging requirements/profiles that are broadly similar to mobile phones. This includes tablets, e-readers, wearables (including smart watches and headphones), speakers, cameras and portable video games. On the other hand, laptops have significantly higher power requirements than mobile phones, and are therefore excluded from the scope of the IA.

Decoupling

Another aspect that is worth discussing relates to possible measures to foster decoupling (i.e. the sale of mobile phones without a charger). As noted previously, increased decoupling is a necessary pre-condition for any initiative to achieve a significant positive environmental impact. It could therefore be considered whether the EU should legislate to make

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53 It should be noted that only a small minority of respondents to the public consultation (13% of all respondents, incl. 15% of responding businesses and business associations) believed that wireless charging would replace wired charging entirely within the next five to ten years.
55 If harmonisation of laptop chargers is to be considered, a dedicated impact assessment would be needed. Given the current status of the market, with multiple charging solutions available, the effects of harmonisation could be very significant, both positive and negative. These effects would need to be analysed in depth and this analysis is not possible within the scope of this study. In addition, it is likely that the “harmonised charger” for laptops would differ significantly from the harmonised charger for phones and similar devices, given the differences in power requirements. This does not preclude, though, that both chargers could be interoperable, albeit with significant differences in performance.
decoupling compulsory (i.e. require mobile phones to be sold without an EPS, or even with neither a cable nor an EPS).

However, this study does not consider mandatory decoupling as an option for the following main reasons:

- It would exceed the scope of the initiative as previously framed in the most recent letter from MEPs, which urges the Commission to make the “common charger” a “reality”, thereby “reducing the necessity to purchase different types of chargers” and giving “the possibility to reuse already owned ones” [emphasis added], the Commission’s inception impact assessment (which focuses on developing a “common charger” and guaranteeing “full interoperability”), the public consultation (which asks respondents for their views on a number of options, but not mandatory decoupling), as well as the Technical Specifications for the present study.

- Thus, there is no clear mandate for the initiative on common chargers to encompass mandatory decoupling. Including such an option would broaden the scope of the study considerably, and could have far-reaching consequences in terms of the nature and scale of the impacts which were not foreseen at the outset, and therefore not built into our approach to the data collection and analysis. It would be very challenging to add this dimension ex post, and attempt to estimate such impacts in a robust and evidence-based way.

- In our view, mandatory decoupling would be a highly interventionist measure (prescribing how manufacturers sell and market their products) for which there is no clear mandate (see above) or obvious legal basis. It would significantly alter the scope of the initiative as previously considered and discussed, in ways that are likely to be highly controversial among not only economic operators but also some consumers (who would no longer have the option of purchasing a “complete” phone, but would have to rely on a charger they already own or purchase separately), and could therefore entail significant risks (e.g. in terms of the EU being accused of excessive “regulatory zeal”). In view of this, we would suggest that, if mandatory decoupling is to be considered further, it would warrant a separate study, with a clear focus on analysing its different effects (whereas the present study focuses on the technical aspects of harmonising charging solutions, which is a very different matter).

However, as part of assessing the (environmental and other) impacts of all of the policy options identified previously, we do estimate the effects on voluntary decoupling that are likely to be achieved. For this purpose, we have developed a range of scenarios, drawing on assumptions based on the greatest extent possible on the available evidence (including consumers’ willingness to consider buying mobile phones without chargers as expressed in the consumer panel survey). As part of this, we have developed more “pessimistic” and more “optimistic” scenarios (for details see section 5.1).

Timeframe

An important question is when any new rules will enter into force. Longer or shorter transition periods could have an impact on the scale of the (positive as well as negative) impacts of any new initiative. But rather than frame these as separate policy options, we have used the following assumption: Any new rules (whether based on regulation or adopted voluntarily by the industry) would apply to all mobile phones sold on the EU market from 1 January 2023. Assuming the initiative would be finalised and adopted in 2020, this provides for a transition period of at least two years before the new rules enter into force. It can then be inferred how a longer or shorter transition period would affect the results.

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56 Letter from a number of MEPs to Commissioner Elżbieta Bieńkowska regarding the Common charger for mobile radio equipment, 5 October 2018
57 C.p. the Commission’s Inception Impact Assessment, Ref. Ares(2018)6473169 - 15/12/2018
58 The inclusion of a “mandatory decoupling” policy option was also discussed and explicitly ruled out at the inter-service group meeting on 15 February 2019 to discuss the inception report.
Finally, the question of the policy instrument that is chosen — voluntary or regulatory action — is obviously of critical importance. However, if one assumes 100% industry compliance with a new voluntary initiative, then its impacts can be expected not to differ from those of a regulation that introduces the same obligations. Therefore, we treat the question of the most appropriate policy instrument as the second (rather than the first) layer of the analysis. In other words, instead of considering the policy instrument first, and then asking what specific rules and requirements it would entail, we focus on the technical content of the options first (as outlined above), and assess the likely impacts of, for example, limiting the connectors on the device end to USB Type-C only. As a second step, we then consider:

- The extent to which these requirements would lend themselves to being achieved via a voluntary initiative, and any inherent risks, caveats or adaptations that would be required.
- What legal basis could be considered for pursuing this option via regulatory action, in particular whether it could be achieved via a Delegated Act under Article 3(3) of the RED, or if a different legal basis would need to be found.

4.3 Options shortlisted for in-depth assessment

Following on from the considerations put forward above, in addition to the baseline, the IA study addresses the following policy options in depth:

- Five specific policy options — three of which concern the connectors at the device end, the other two the external power supply (EPS).
- These two types of options are not mutually exclusive — where relevant, we consider the cumulative impacts of harmonising both the device-end connectors and the EPS.
- For each of the five options, we also provide an account of:
  - the main impacts that extending its scope to other portable electronic devices would have, and
  - the likely effectiveness of different instruments, including (a) the potential for achieving the desired level of harmonisation via a voluntary industry commitment, and (b) whether it could be regulated via a Delegated Act under Article 3(3) of the RED, or if a different legal basis would be required.

The options and ancillary considerations are summarised in Table 16 below.

Table 16: Summary of the approach to assessing the policy options

| Connectors at the device end | EPS |
| Policy options for mobile phone chargers | 0. Baseline (2018 MoU: USB Type-C or proprietary, adaptors available to purchase) | 1. USB Type-C only | 2. USB Type-C only, for phones with proprietary receptacles, adaptors in the box compulsory | 3. USB Type-C or proprietary, for cables with proprietary connectors, adaptors in the box compulsory | 4. Guaranteed interoperability of EPS | 5. Interoperability plus minimum power requirements for EPS |

| Consideration of scope | N/A | Extend scope to chargers for other portable electronic devices with similar charging requirements to mobile phones? |

| Consideration of policy instrument | N/A | Potential for achieving harmonisation via a voluntary industry commitment |

| | N/A | Legal basis for possible regulatory action |

The main features of each option, as well as a graphical representation of their main features, are provided in the table overleaf.
<table>
<thead>
<tr>
<th>Option</th>
<th>Visualisation</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. Baseline (2018 MoU)</td>
<td>USB Type C</td>
<td>As per the MoU proposed by industry in 2018, cable assemblies can have either a USB Type-C or a proprietary connector at the device end. It is assumed that adaptors continue to be available for purchase.</td>
</tr>
<tr>
<td>1. USB Type-C only</td>
<td>USB Type-C</td>
<td>Only cable assemblies with a USB Type-C connector at the device end are allowed. Cable assemblies that require adaptors are not considered compliant.</td>
</tr>
<tr>
<td>2. USB Type-C only; for phones with proprietary receptacles, adaptors in the box compulsory</td>
<td>USB Type-C</td>
<td>Only cable assemblies with a USB Type-C connector at the device end are allowed. Manufacturers that wish to continue to use proprietary receptacles in their phones are obliged to provide an adaptor from USB Type-C to their proprietary receptacle in the box.</td>
</tr>
<tr>
<td>3. USB Type-C or proprietary; for cables with proprietary connectors, adaptors in the box compulsory</td>
<td>USB Type-C</td>
<td>Cable assemblies can have either a USB Type-C or a proprietary connector at the device end. Manufacturers that choose to provide a cable with a proprietary connector are obliged to provide an adaptor in the box that enables its use with a USB Type-C receptacle.</td>
</tr>
<tr>
<td>4. Guaranteed interoperability of EPS</td>
<td>IEC 62680 IEC 63002</td>
<td>Commitment (via a voluntary agreement or an essential requirement enshrined in regulation) to ensuring all EPS for mobile phones are interoperable. This would be concretised via reference to compliance with the standards IEC 62680-1-3 (for chargers up to 15W) as well as IEC 62680-1-2 and IEC 63002 (for chargers above 15W).</td>
</tr>
<tr>
<td>5. Interoperability plus minimum power requirements for EPS</td>
<td>Min. 15W</td>
<td>To facilitate adequate charging performance, all EPS for mobile phones would have to guarantee the provision of at least 15W of power (in line with most current fast charging technologies). To also ensure full interoperability, all EPS would have to be capable of “flexible power delivery” in accordance with common (USB PD) standards / specifications.</td>
</tr>
</tbody>
</table>
5 Impact assessment

This chapter provides an estimation of the most significant impacts of each of the policy options shortlisted for in-depth assessment. Quantitative or (where this is not feasible with the information and methodologies at hand) qualitative estimates are made based on the available primary and secondary data, and a range of assumptions to fill gaps and model the likely effects of the different options.

This chapter starts by defining scenarios for decoupling (which are relevant to assessing a number of impacts). It then goes on to analyse the main social (5.2), environmental (5.3), and economic (5.4) impacts we expect the initiative to have (the most relevant impacts were selected based on an initial screening of a wide range of types of impacts). The chapter ends with a discussion of a number of issues that are important to consider when it comes to the implementation, including the technical feasibility and acceptability of the options, potential indirect impacts on other portable electronic devices, and consideration of the policy instrument (regulatory or voluntary action).

5.1 Decoupling scenarios

As noted previously (and discussed further in the ensuing sections), one of the key drivers of the likely impacts of any initiative to harmonise chargers is the extent to which it leads to decoupling, i.e. the sale of phones (and potentially other types of portable electronic devices) without a charger. Without a mandatory requirement for manufacturers and distributors to decouple chargers from phones (which could be considered in principle, but falls outside of the scope of this study, as discussed in section 4.2 above), the decoupling rates achieved will depend on "organic" market developments, namely the extent to which manufacturers and distributors decide to offer phones without chargers in the box, and the extent to which consumers choose to purchase these. This is inherently difficult to predict. For this study, we have to rely on a number of assumptions and scenarios, based to the extent possible on the available evidence. However, it is important to emphasise that these are subject to a high degree of uncertainty; we can consider the decoupling rates that appear possible under different scenarios, and the likelihood that different policy options will help to achieve these rates, but not make any definitive predictions about how the market will evolve.

Key factors for consideration

As briefly outlined previously (see section 3.3), the extent to which mobile phones are currently sold in Europe without chargers is negligibly small. In the past, schemes to sell certain phones without an EPS (but including a cable) were trialled by Motorola and by the UK network carrier O2 around 2013, but despite some early successes, both appear to have been discontinued. At present, to the best of our knowledge, the only company in Europe to actively promote decoupling is Fairphone, which sells all its phones without a charger (EPS or cable) by default, mainly in an effort to reduce e-waste, and claims that only around 25% of its customers opt to add a charger to their order. However, Fairphone’s share of the European mobile phone market is too small to figure in the IDC shipments data for 2018.

Some other portable electronic devices are currently being sold with only a cable, but no EPS. This was the case of the majority of the action cameras, wearables, and e-readers in the sample we reviewed (see section 3.4). This suggests there

9 RPA (2014), pp. 24-25
is scope for potentially extending such an approach to mobile phones. However, it should be noted that, according to manufacturers, the decision not to ship these devices with an EPS is often partly motivated by the assumption that nearly all consumers own a mobile phone, and will be able to use their mobile phone charger for these devices as well. Therefore, a widely held view among industry stakeholders is that the situations are not directly comparable.

In the consumer panel survey, respondents were asked whether they would consider purchasing a mobile phone without a charger. 40% categorically ruled out purchasing a phone without a charger, and 36% also ruled out purchasing a phone with only a charging cable, but no EPS included (see the figure below). The main reasons provided for the insistence on a charger being included in the box were not having to worry about how to charge the phone, and that it ensures that the charger works well and is safe. On the other hand, 12% of survey respondents stated they would actually prefer to purchase a phone with a cable but no EPS, and 9% would prefer a phone with no charger at all. The remainder responded they would be willing to consider this, but only if it meant the price of the phone (or the overall cost of the contract over its duration) was reduced by at least EUR 5 (cable only) or at least EUR 10 (no EPS or cable). However, when interpreting these responses, it should be noted that some of the higher discounts respondents stated would be needed for them to consider buying a phone without a charger (up to EUR 50) appear unrealistic, given the actual prices of chargers (see section 5.4 below). When asked why they would consider buying a mobile phone without a charger, in addition to saving money, significant numbers of these respondents also mentioned environmental concerns (a desire to save resource and reduce electronic waste) and convenience benefits (as they claim to already have too many chargers).

Figure 25: Consumer willingness to consider decoupling

Source: Ipsos consumer panel survey, n = 5,002
NB: The "Yes, but ..." response options in the legend above are abridged for better readability. The full text of all these response options read: "Yes, but only if it meant the price of the phone / the overall cost of my contract over its duration was reduced by at least EUR ..." The price increments provided were different for the two questions: between EUR 10 and EUR 50 for phones "without a charger, i.e. with neither external power supply nor cable assembly provided", and between EUR 5 and EUR 15 for phones "with only a charging cable provided, and no external power supply included".
Figure 26: Main reasons why consumers are unwilling to consider decoupling

Why do you prefer to buy a mobile phone bundled with a charger?

- It means I don't have to worry about how I can charge the phone: 68%
- It ensures that the charger works well: 38%
- It ensures that the charger is safe, as I trust my preferred mobile phone brand: 34%
- It ensures that the charger offers highest performance in terms of charging time: 23%
- Other: 1%

Source: Ipsos consumer panel survey, n = 2,097

Figure 27: Main reasons why consumers would consider decoupling

Why would you consider to buy a mobile phone without a charger?

- It would allow me to save resource and reduce electronic waste: 55%
- It would be more convenient for me (I already have too many chargers): 46%
- It would allow me to save money: 40%
- Other: 1%

Source: Ipsos consumer panel survey, n = 2,189

Most industry stakeholders were somewhat sceptical of the potential for extensive decoupling. Many argued that consumers expect a charger in the box (which is only partly confirmed by our survey results), and that having a fully operational phone in the box is an important part of the consumer experience, particularly with high-end devices. Mobile manufacturers also expressed concerns about the lack of control decoupling would entail – in particular the risk of consumers using inappropriate and/or sub-standard chargers, which not only lead to sub-optimal charging performance, but can also cause damage to the battery as well as potentially serious safety issues (see section 3.9). In this context, industry stakeholders also raised concerns about the potential implications for the certification process (as phones and accompanying chargers are usually tested and certified together, and some stakeholders were unclear how this process would work if there was no charger 'in the box'), and worried about questions of reputational damage from, as well as
accountability and responsibility for, any performance or safety issues that might arise, as they believed consumers would ultimately tend to blame (and potentially seek compensation from) the phone manufacturer (rather than the charger manufacturer) for any damage caused. Other concerns mentioned included the useful life of the charger, which may need to be replaced as frequently as the mobile phone, and the fact that consumers use mobile phone chargers to charge other devices.

Scenarios and key underlying assumptions

In light of the factors and evidence briefly outlined above, we have developed a set of decoupling scenarios to help analyse the potential impacts of the different policy options for a common charger. While none of the options involve an explicit commitment or obligation to decouple chargers from phones, the options have the potential to contribute to increasing decoupling rates by achieving further harmonisation and ensuring interoperability of chargers. In general terms, this can be expected to enhance both the awareness of consumers that chargers can be used across a range of devices, and their saturation rate with interoperable chargers (i.e. the extent to which they have access to / are “saturated” with a sufficient number of compatible chargers), and thereby reduce their demand for a new charger in the box with each new phone they purchase. In order to estimate the effects of this, we have taken a two-step approach:

1. First, we have developed a set of ‘generic; decoupling cases, for both EPS and cables, to reflect a range of more or less optimistic scenarios around how much decoupling appears achievable. These scenarios are described in the remainder of this section.
2. Second, we have linked these scenarios to the different policy options, by considering the potential of each option to achieve the decoupling rates estimated under the first step. This is further discussed in the final part of this section.

The three scenarios (first step) are described below, representing a range of more or less optimistic outcomes over time. All three scenarios are based on a set of common assumptions, namely:

- Main charger components: For a number of reasons, it is ‘easier’ to sell phones with only a cable than it is to sell them with no charger at all (no EPS or cable). This is partly due to the typically higher cost of the EPS compared with cables (meaning there are more significant savings from decoupling), as well as the fact that the cables are not only used for charging, but also for data transfer. The greater openness of consumers to purchase devices with a cable but no EPS is also reflected in the fact that certain devices are already routinely sold with only a cable, and confirmed by the results of our consumer panel survey (see above). Therefore, we have assumed for cables to be half that for EPS across all scenarios.

- Current decoupling rate: As noted above, the extent to which mobile phones are sold without chargers in Europe at the moment is negligible: Fairphone is the only supplier we are aware of, with a market share significantly below 0.1%. In our consumer panel survey, a little over 1% of respondents claimed to have purchased at least one charger in the last five years because their mobile phone did not include a charger, but this figure is unlikely to be an accurate reflection of the market (e.g. it may well include second-hand phones, which are more likely to be sold without a charger). Therefore, as the baseline for our estimates, we assume that, in 2020, 0% of phones are sold without EPS or cable.
• Evolution of decoupling rates over time: As noted previously (section 4.2), we assume that any new rules stemming from the policy options would apply to all mobile phones sold on the EU market from 1 January 2023. Considering this, as well as the apparent market trend (gradual substitution of 'legacy' USB connectors with USB Type-C connectors at both the device and EPS end — albeit much more slowly for the latter), we therefore assume that, as the markets adapt to the new rules, and consumer saturation with compatible chargers increases, decoupling rates will start to increase from 2021, and reach the maximum rates under each scenario by 2023. They then remain constant for three years, before beginning to drop (by 20% per year), reflecting the likely emergence of newer technologies and standards, and hence the need for consumers to adapt to a new 'generation' of charging solutions.

The lower case scenario

The first scenario is the most pessimistic one (though still more optimistic than the baseline, which assumes no increased decoupling). It assumes only very limited growth in decoupling rates, as a result of the greater consumer saturation with interoperable chargers leading some manufacturers and/or distributors to offer mobile phones without chargers in certain market segments. However, in this scenario, decoupling would remain the exception, as most major market players would continue to include a charger (both cable and EPS) in the box of all of their phones. As such, the decoupling rates achieved under this scenario do not exceed 5% for EPS, and 2.5% for cables.

Table 18: Decoupling rate assumptions: lower case

<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
</tr>
</thead>
<tbody>
<tr>
<td>No EPS</td>
<td>0%</td>
<td>2%</td>
<td>3%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>4%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>No cable</td>
<td>0%</td>
<td>1%</td>
<td>1.5%</td>
<td>2.5%</td>
<td>2.5%</td>
<td>2.5%</td>
<td>2%</td>
<td>1.5%</td>
<td>1%</td>
</tr>
</tbody>
</table>

The mid case scenario

The second scenario is intended to provide a realistic (but by no means certain) projection in which manufacturers and distributors increasingly cater to the preferences of those consumers who prefer to purchase mobile phones without chargers. It assumes the emergence of a significant number of schemes that allow consumers to opt out of having an EPS and/or cable included in the box of their new phones, potentially in return for a small discount (which, in view of the production cost of chargers, would be very unlikely to exceed EUR 5). However, the coverage of such schemes would not be universal, and their take-up would remain limited to consumers with a high awareness of the interoperability of charging solutions, and the environmental implications of the production and disposal of large numbers of (unnecessary) chargers. Broadly in line with the results of our consumer survey (for respondents who would prefer to purchase phones without chargers even without a discount), this would result in a decoupling rate of 15% for EPS, and 7.5% for cables, by 2023.

Table 19: Decoupling rate assumptions: mid case

<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
</tr>
</thead>
<tbody>
<tr>
<td>No EPS</td>
<td>0%</td>
<td>5%</td>
<td>10%</td>
<td>15%</td>
<td>15%</td>
<td>15%</td>
<td>12%</td>
<td>9%</td>
<td>6%</td>
</tr>
<tr>
<td>No cable</td>
<td>0%</td>
<td>2.5%</td>
<td>5%</td>
<td>7.5%</td>
<td>7.5%</td>
<td>7.5%</td>
<td>6%</td>
<td>4.5%</td>
<td>3%</td>
</tr>
</tbody>
</table>
The higher case scenario

The third (and most optimistic) scenario is intended to reflect the "maximum possible" decoupling rate that appears achievable, assuming full buy-in from manufacturers and distributors, and an increased willingness of consumers to re-use chargers they already own to charge their new phones. To achieve this, it may be necessary to take certain supporting measures. The European Commission and/or national authorities could work proactively with the industry to encourage (and, if possible, incentivise) it to participate. Similarly, consumer confidence in the interoperability and safety of chargers, and awareness of the environmental benefits of decoupling, could be enhanced via targeted information / education campaigns, potentially also including new / enhanced labelling and/or certification requirements. It might also be worth considering whether provisions to limit phone manufacturers' liability for damage caused by substandard third party chargers would need to be clarified and potentially strengthened.

Under this scenario, we assume a maximum decoupling rate of 40% for EPS, and 20% for cables. This reflects the fact that, given consumer preferences, ownership of interoperable chargers from other phones or devices, and the lifetime of chargers, there will always continue to be demand for a significant number of new chargers. This decoupling rate is consistent with the results of the 2014 RPA study60, as well as the fact that around half of respondents to our consumer survey (not counting those who responded "don't know") stated they would not consider buying a phone without a charger even if it was significantly cheaper.

Table 20: Decoupling rate assumptions: higher case

<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
</tr>
</thead>
<tbody>
<tr>
<td>No EPS</td>
<td>0%</td>
<td>10%</td>
<td>25%</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
<td>32%</td>
<td>24%</td>
<td>16%</td>
</tr>
<tr>
<td>No cable</td>
<td>0%</td>
<td>5%</td>
<td>12.5%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>16%</td>
<td>12%</td>
<td>8%</td>
</tr>
</tbody>
</table>

It is important to reiterate that none of these scenarios should be interpreted as firm predictions. Increased decoupling rates would not be a direct consequence of the policy options as defined within the scope of the present study, and as such, any predictions regarding how the markets would react are subject to significant uncertainty. Nonetheless, in what follows, we provide an assessment of the likelihood of and extent to which the different options could help to achieve the scenarios outlined above.

The likely effects of the policy options on decoupling rates

As discussed at length previously, the policy options relate to harmonising different elements of charging solutions, namely the connectors at the device end, and the external power supply (EPS). If implemented, such harmonisation is expected to contribute to making decoupling more attractive to consumers (as their saturation with compatible charging

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60 Cp. RPA (2014). According to RPA, 50% of devices sold without a charger is seen as the highest possible rate, based on the levels of ownership of devices at the time and expected charging behaviour of consumers. However, it notes that in product sectors which are characterised by a high innovation and short product lifecycles, the 50% rate may never be achieved.
solutions, as well as their awareness of and confidence in the interoperability of chargers increases), which in turn could lead more economic operators to make available 'unbundled' solutions on the EU market (assuming their other concerns can be addressed).

In the table below, we consider the extent to which the preconditions for increased decoupling are likely to be affected under each of the specific policy options being considered, and hence which of the scenarios outlined above appears most relevant. The scenarios resulting from this should be seen as the "best case" for each option, rather than a firm prediction. In other words, for example, while we cannot be sure that option 1 would lead to a certain decoupling rate, we conclude that, in isolation (i.e. without any other accompanying measures), a common (USB Type-C) connector at the phone end would be very unlikely to lead to anything more than the lower case scenario as defined previously.

Table 21: 'Best case' decoupling assumptions under each policy option

<table>
<thead>
<tr>
<th>Elements</th>
<th>Options</th>
<th>Notes</th>
<th>Best case decoupling scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>Option 0</td>
<td>The baseline scenario assumes no further harmonisation of charging solutions, and hence no increase in the current decoupling rates, which is so low (likely in the range of 0.01%) as to be negligible for the purpose of our analysis.</td>
<td>Status quo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(no decoupling)</td>
<td></td>
</tr>
<tr>
<td>Device-end connectors</td>
<td>Option 1</td>
<td>If only cable assemblies with a USB Type-C connector at the device end are allowed, this would obviously make all cables interoperable across all phone manufacturers and models. However, as cables are intrinsically less likely to be unbundled (given they also fulfil data transfer functions), this alone is unlikely to significantly increase demand for decoupled solutions. Therefore, we conclude that this option is unlikely to achieve decoupling rates beyond the lower case scenario.</td>
<td>Lower case</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(max. 5% for EPS, 2.5% for cables)</td>
<td></td>
</tr>
<tr>
<td>Option 2</td>
<td></td>
<td>The possibility for manufacturers who wish to use proprietary receptacles in their phones to make this interoperable with the USB Type-C connector on the cable by including an adaptor in the box makes no material difference to the decoupling scenarios as such. Like option 1, it increases consumer saturation with compatible cables, but is subject to the same limitations.</td>
<td></td>
</tr>
<tr>
<td>Option 3</td>
<td></td>
<td>Allowing manufacturers to provide cables with proprietary connectors, but requiring them to include an adaptor in the box to make the cable usable with devices that have USB Type-C receptacles, would also increase consumer saturation with interoperable cables (although in some cases an adaptor would be required). Thus, like options 1 and 2, we assume it would lead to a modest increase in decoupling rates.</td>
<td></td>
</tr>
</tbody>
</table>
As can be seen in the table above, the potential for most options to achieve significantly increased decoupling rates appears relatively limited. The highest possible rates only appear plausible as a result of the maximum harmonisation options for both the device-end connectors and the EPS. Even then, it is important to emphasise again that this is the best case scenario, and depends on a range of factors, including possible accompanying information campaigns or other measures taken by the Commission and/or other public authorities, and the specific commercial and other decisions made by economic operators. Therefore, whenever we refer back to the achievable decoupling rates in the ensuing sections, the very high degree of uncertainty regarding these should be kept in mind.
5.2 Social impacts

The most relevant (i.e. potentially significant) social impacts of the initiative, which are discussed in this chapter, are:

- Consumer convenience benefits from increased harmonisation of charging solutions
- Impacts on product safety, in terms of the risk of injury or damage to consumers
- Impacts on the illicit market for mobile phone chargers (which is a criminal activity) and its effects

Consumer convenience

As discussed previously (see section 3.5 for details), our survey of a representative panel of consumers suggests that between around one third and one half of EU consumers have experienced each of a series of issues causing them inconvenience in relation to mobile phone chargers at least once over the course of the last two years. Broadly speaking, the sources of consumer inconvenience can be divided into four sets of issues, with those experienced by the highest number of consumers listed first:

a) **Inability to charge certain devices (as fast) with certain chargers:** Around half of all survey respondents reported having experienced problems due to not being able to charge their new phone with their old charger (46%), not being able to charge their phones as fast with another charger (53%), or not being able to charge other electronic devices with their phone charger (49%). A little under half of these felt that this caused significant issues, meaning that the proportion of all respondents who had experienced each of these problems at least once, and for whom they had caused significant issues at least from time to time, was slightly over 20%.

b) **Too many chargers:** The survey results suggest that a little over half (53%) of consumers feel they have too many chargers taking up space in their home and/or workplace, but only around four out of ten of these (or 21% of all respondents) considered this to cause significant issues. In a similar vein, 40% reported that, on at least one occasion, they were provided a new charger with a new phone when they would have preferred to keep using a charger they already had; but only a little over a third of these (or 15% of all respondents) thought this was significant.

c) **No access to a compatible charger:** Three out of eight survey respondents (38%) reported having been in a situation where they needed to charge their phone, but the available chargers were incompatible with it. Out of these, half (19% of all respondents) had only experienced this once or twice in the last two years, while four out of ten (15% of all respondents) had experienced this on a few occasions, and around one in ten (4% of all respondents) on numerous occasions. When asked about the seriousness of this problem, 49% of those who had experienced it (or 19% of all respondents) reported it had caused them significant issues.

d) **Confusion about which charger works with what:** Around a third of survey respondents reported having been confused about which charger to use for which mobile phone (30%) or other portable electronic device (35%). Compared with the issues covered above, confusion tends to arise less frequently (only 6% had experienced this on numerous occasions or almost every day). Nonetheless, regarding both mobiles and other devices, about half of
these who had experienced confusion (or 15-17% of all respondents) reported this had caused them significant issues from time to time.

In summary, annoyance at having too many chargers for mobile phones and other portable devices, and at the lack of interoperability between them, appear to be the main sources of inconvenience, experienced at least occasionally by around half of consumers. Situations where consumers are unable to gain access to a suitable charger for their phone, or are confused about which charger can be used for which phone or device, occur relatively less frequently (around one in three consumers). Nonetheless, the proportion of respondents who reported having experienced significant issues was quite similar across all of the problems listed (between 15% and 22% of all respondents). In the remainder of this section, we consider how the different policy options would be likely to affect consumer (in)convenience of the four main types outlined above. The main results are summarised in the table below.

Table 22: Main effects of the policy options on consumer convenience

<table>
<thead>
<tr>
<th>Sources of inconvenience</th>
<th>Connectors at the device end</th>
<th>EPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Inability to charge certain devices (as fast)</td>
<td>Option 1</td>
<td>Option 2</td>
</tr>
<tr>
<td>+</td>
<td>Enhanced ability to charge all phones with the same cables</td>
<td>+/-</td>
</tr>
<tr>
<td>b) Too many chargers</td>
<td>+</td>
<td>Assumes small increase in decoupling rates</td>
</tr>
<tr>
<td>c) No access to a compatible charger</td>
<td>++</td>
<td>Increases likelihood of finding compatible charger for all users</td>
</tr>
<tr>
<td>d) Confusion about which charger works with what</td>
<td>0</td>
<td>Negligible impact, as amount of confusion from connectors seems very limited (except among the visually impaired)</td>
</tr>
</tbody>
</table>

Table 22: Main effects of the policy options on consumer convenience
Connectors at the device end | EPS
--- | ---
**Unweighted average without decoupling** | + | 0 | 0 | + | +
**Unweighted average with decoupling** | + | 0/+ | 0/+ | ++/+ | ++/+ 

**Option 1**

A common universal USB Type-C connector at the phone end could be expected to affect the main sources of consumer (in)convenience as follows:

a) **Inability to charge certain devices (as fast) with certain chargers**: Minor positive impact. The common connector would ensure that consumers can use the cable supplied with their mobile phone to charge any mobile phone irrespective of the brand or model, and potentially also a wide range of other portable electronic devices (for details on this see section 5.5). While this is expected to be the case anyway for the majority of consumers (the baseline scenario foresees a convergence of large parts of the market towards USB Type-C connectors), this option would eliminate proprietary connectors and thus extend the benefits to all users. However, it should be noted that, during the transition, there would be a one-off negative effect on some users: when current Apple users purchase the first new phone that complies with this requirement, the effect will be the opposite, i.e. they will not be able to charge their new phone with their old (Lightning) cable. This option also does not have any effects on the existing variations in charging performance, i.e. would not ensure users can charge their phones at the same speed irrespective of the charger they use.

b) **Too many chargers**: Minor positive impact. The number of chargers owned by consumers is a direct function of the decoupling rates achieved. As outlined previously (see section 5.1), we have assumed only a small increase in the proportion of phones sold without chargers to result from this option.

c) **No access to a compatible charger**: Major positive impact, especially for users whose phone currently have proprietary connectors. A common connector at the device end would significantly increase the likelihood that users who run out of battery, but have no access to their own charger (e.g. because they are travelling), are able to find a compatible charger. The likelihood would be most significantly increased for the minority of users whose phones currently rely on proprietary connectors. However, it should be noted that, according to the survey results, lack of access to a compatible charger is a relatively infrequent occurrence. Furthermore, it is important to keep in mind that a common connector would only provide convenience gains for consumers who find themselves in specific situations that meet all of the following conditions.61

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61 These conditions are taken from CRA (2015): Harmonising chargers for mobile telephones
• The consumer is not at a "usual" location, such as place of work or home, where he/she has taken steps to have his/her own charging equipment available, and
• The consumer has not carried his/her own charging equipment, and
• The consumer’s mobile phone battery has expired or is about to expire, and so requires re-charging to avoid constraining the consumer’s use of his/her phone, and
• There is a charging point available to be used with a charger (i.e. the consumer is not outdoors or in another public place where there are no charging points available for use), and
• There are one or more available chargers provided by a third party, none of which would have been compatible with the consumer’s phone in the absence of this policy option.

d) Confusion about which charger works with what: Negligible impact. Although this was not specifically asked in the survey, it appears reasonable to assume that confusion arises primarily about the use of different EPS, whereas the interoperability of different connectors with different receptacles should be obvious to most consumers. Some exceptions may apply in the case of consumers with a sensory (especially visual) impairment, who might struggle to distinguish different types of connectors, and could therefore benefit from reduced confusion under this option.

Option 2

This option also creates a common USB Type-C connector at the phone end of the cable assembly, but gives manufacturers who wish to use proprietary receptacles in their phones the possibility to make these interoperable with the cable by including an adaptor in the box. The impacts on consumer convenience would differ from those of option 1 above in the following main ways:

a) Inability to charge certain devices (as fast) with certain chargers: Minor positive as well as negative impacts for different types of consumers. In general, the proliferation of cables with USB Type-C connectors would increase users' ability to use these to charge a wider range of phones, and thus reduce inconvenience, as described above. However, the net effect is less clear for users of phones with proprietary receptacles (in case certain manufacturers were to continue to use these), as the increased ability to use the charging cable for other phones would be at least partly offset by the inconvenience caused by having to use an additional accessory - namely the adaptor - each time they charge their main phone.

b) Too many chargers: Minor positive impact. We assume that option 2 (like option 1) would result in a small increase in the proportion of phones sold without chargers (see section 5.1).

c) No access to a compatible charger: Minor positive impact. For the majority of mobile phone users, the effect of this option is largely identical to that of option 1 above. However, users of phones with proprietary receptacles would only benefit if they either carry their own adaptor with them, or the correct adaptor happens to be provided by the third party whose charger is being used - both of which seems relatively unlikely.

d) Confusion about which charger works with what: Negligible impact. As outlined under option 1, confusion about the interoperability of different connectors with different receptacles is likely to be very rare.
Option 3

If manufacturers are allowed to continue to provide cables with proprietary connectors, but obliged to include an adaptor in the box to make the cable usable with devices that have USB Type-C receptacles, the effects on consumer convenience would differ from those of option 1 in the following main ways:

a) **Inability to charge certain devices (as fast) with certain chargers**: Minor positive impacts for some consumers only. By taking advantage of the adaptor provided, users of phones with proprietary receptacles could use the corresponding charger to also charge other devices (incl. phones) with USB Type-C receptacles. However, the majority of users who only own mobile phones that come with USB Type-C receptacles (and the corresponding cables) would reap no benefits from this option.

b) **Too many chargers**: Minor positive impact. Like both of the options discussed previously, option 3 is assumed to only result in a small increase in the proportion of phones sold without chargers (see section 5.1).

c) **No access to a compatible charger**: Negligible / minor positive impact. As cables with proprietary connectors would still be in use, this option increases the likelihood that consumers are able to find a compatible charger only marginally. The effect would be limited to the relatively unusual scenario in which a user of a phone with a USB Type-C receptacle happens to come across a third party charger with a proprietary connector plus an adaptor. In all other scenarios, there would be no benefits from this option.

d) **Confusion about which charger works with what**: Negligible impact. As outlined under option 1, confusion about the interoperability of different connectors with different receptacles is likely to be very rare.

Option 4

This option would ensure all EPS for mobile phones are interoperable by mandating compliance with the relevant international standards. This would be likely to affect consumer convenience as follows:

a) **Inability to charge certain devices (as fast) with certain chargers**: Minor positive impact. As outlined previously, EPS shipped with mobile phones can typically already be used to charge a wide range of other phones / devices. However, there are no guarantees of this, and many consumers’ awareness of the extent to which EPS are interoperable with different phones appears limited. This option would ensure all modern EPS work with all modern mobile phones, as well as other devices implementing the USB Type-C and/or USB PD standards. This would enhance consumer awareness of and confidence in their ability to use their EPS across a range of devices (especially if accompanying information measures were taken to communicate the new requirements widely), and thereby significantly reduce one source of inconvenience (especially if action was taken simultaneously to address connectors, as per the first three options) – although it should be noted that charging speeds may still vary.

b) **Too many chargers**: Major positive impact. A reduction in the number of chargers owned by consumers would only occur as a result of decoupling. This option is assumed to result in a more significant increase in the proportion of phones sold without chargers compared with the options discussed above (see section 5.1). This could be even higher if the connectors were harmonised fully at the same time (option 1). In addition, an indirect effect on other portable electronic devices appears possible: the guarantee that EPS sold with mobile phones comply with the relevant standards could lead more manufacturers to consider selling such devices without an EPS.
c) **No access to a compatible charger**: Negligible / minor positive impact. As noted above, most EPS sold with mobile phones are already interoperable with a wide range of different phones. In situations where consumers require access to a third party charger, the main interoperability barrier tends to be the connector. Therefore, the number of occasions in which consumers find themselves in this situation, and would benefit from this option (i.e. would not have otherwise had access to a compatible EPS), is likely to be very small.

d) **Confusion about which charger works with what**: Major positive impact. Although the level of interoperability of EPS with different mobile phones is already high, the survey results suggest that consumers are not necessarily aware of this. Guaranteed interoperability in accordance with relevant standards could help reduce confusion in this respect significantly, especially if accompanying information measures were taken.

**Option 5**

If EPS for mobile phones were subject to interoperability as well as minimum power requirements, consumer convenience would be affected in the following main ways:

a) **Inability to charge certain devices (as fast) with certain chargers**: Major positive impact. In addition to the effects of option 4 (see above), this option would also ensure consumers are able to charge their phones with another charger at a similarly fast speed, and thereby largely eliminate a source of inconvenience experienced by the majority of consumers according to the survey.

b) **Too many chargers**: Major positive impact. This option is assumed to achieve similar decoupling rates as option 4 above (see section 5.1). As with option 4, this could be even higher if the connectors were harmonised fully at the same time (option 1). An indirect effect on higher decoupling rates for certain other portable electronic devices also appears possible.

c) **No access to a compatible charger**: Negligible / minor positive impact, for the same reasons as option 4 (see above).

d) **Confusion about which charger works with what**: Major positive impact, for the same reasons as option 4 (see above).

In summary, all five policy options would have a positive net effect on consumer convenience, but the ways in which they affect different consumers in different circumstances varies. These effects need to be seen against the backdrop of the relatively high rates of convergence and interoperability for both connectors and EPS expected under the baseline scenario (see section 4.1), which means the effects of the options on the convenience of the majority of consumers would be incremental rather than “game-changing”.

Common connectors at the device end (option 1) would be most effective in terms of increasing the likelihood that consumers who are unable to access their own charger (e.g. because they are travelling) are able to find a compatible third-party charger, and would also enhance convenience by enabling users to charge all phones with the same cables. Similar benefits would arise if adaptors are allowed (options 2 and 3), but these would be less pronounced overall, and could be partly outweighed by the inconvenience caused by having to use adaptors. Harmonisation of the EPS (options 4 and 5) would have major benefits in terms of ensuring consumers can charge different devices with their chargers, and reducing confusion in this respect. However, we expect it to only have a negligible (or minor at best) impact on consumers who require access to a compatible third-party charger.
The extent to which all options would lead to a reduction of the inconvenience consumers experience due to having too many chargers taking up space in their homes and/or workplaces depends on the decoupling rates that are achieved voluntarily. As discussed previously (see section 5.1.), these are inherently difficult to estimate, but we assume that the highest potential for decoupling results from options 4 and 5, especially if combined with option 1.

Overall, if we attribute the same weight to all forms of consumer (in)convenience described above, this means that the options that are likely to generate the most significant benefits to consumers is option 5, closely followed by option 4. On the other hand, options 2 and 3 are likely to generate only relatively minor benefits overall. If decoupling on the scale we have estimated occurs, this slightly increases the consumer convenience benefits of all options, but does not affect their relative ranking.

Product safety

Charger safety is an important issue for consumers, phone manufacturers and authorities. As highlighted in section 3.9, unsafe and/or non-compliant charging devices account for a relatively large share of the alerts for electrical equipment which are registered by authorities on the EU RAPEX and ICSMS systems, with some evidence of an increasing trend in recent years. The issue primarily affects standalone charger sales, where outside of the quality assurance of phone manufacturers and other reputable OEMs, there are many products where compliance with safety and other standards is not guaranteed. Little known brands, unbranded and counterfeit products were the subject of most safety alerts. The growth of direct online purchasing of chargers has made it more difficult for market surveillance and public safety authorities to police the quality and safety of chargers that are entering the market. The majority of safety issues relate to the EPS component, with the most serious risks including fire and electrocution hazards for consumers, but also link to issues of device performance and failure which can impinge on consumer convenience. Manufacturers were strongly of the opinion that it is important for them to provide chargers with their phones to guarantee the quality, safety and performance of the devices, from both a consumer satisfaction and legal responsibility perspective (in the case of failure or safety issues).

In the first instance, we have considered the requirements to be introduced by the policy options, without taking into account their potential effects on decoupling rates (these are discussed separately below). The policy options as such do not directly address the product safety issue itself, but may have some indirect impacts. We identify the following factors impacting on product safety:

- Conformity around a single harmonised standard, is understood to provide also a single standardised template for low quality producers and counterfeiters to use.
- Increased power requirements can increase the severity and risk of electrocution and fire hazards from non-compliant products.
- Adoption of harmonised standards such as IEC 62680-1-3, IEC 62680-1-2 and IEC 63002, can reduce product safety risks when using chargers with other phones and devices.

We evaluated the impact of the options as follows, but it should be noted that there was very little data or feedback specifically on these issues. Nevertheless we would expect any impacts to be relatively small and mostly to affect the non-compliant and counterfeit products in the standalone charger market.
Table 23: Main effects of the policy options on product safety

<table>
<thead>
<tr>
<th>Connectors at the device end</th>
<th>EPS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option 1</strong></td>
<td><strong>Option 2</strong></td>
</tr>
<tr>
<td>Product safety impact</td>
<td>0/-</td>
</tr>
<tr>
<td>Change to cable connectors</td>
<td>Same as option 1, but addition of adaptors may open area of additional safety concerns</td>
</tr>
</tbody>
</table>

**Option 1**

A common universal USB Type-C connector at the phone end would not be expected to have a significant effect on product safety. Adjusting to a single cable connector type on the device side would reduce the number of different cables, but the EPS, where the main safety issues are found would not be affected. It is possible that reducing the number of cables would make it easier for counterfeit products and irresponsible manufacturers to enter the market, but the difference from the baseline would be very small.

**Option 2**

This option is seen as having a similar impact to option 1, the only difference in potential impact is the introduction of an adaptor for connecting a USB C cable to a proprietary port on the device. Adaptors are small, simple components, which brings both advantages and risks: advantages as there is a minimum that can go wrong, but risks that they are not complex enough to deal with the range of potential power demands of devices. No additional data or feedback on product safety and charger adaptors was found, therefore our conclusion on impact is not significantly different from option 1, but with a note that uncertainties are higher.

**Option 3**

The same impacts are assessed as for option 2, with the number of adaptors remaining the same, with just the connectors reversed. No tangible difference is foreseen between the two different adaptors.

**Option 4**

Ensuring all EPS are interoperable by mandating compliance with the relevant international standards would likely reduce any residual product safety risks on the EPS side that may result from the growth in fast charging. It is unclear what kind of impact this would have on safety risks from non-compliant and counterfeit products, as per definition these do not always conform to standards.
Option 5

The impact of mandating minimum power requirements for EPS on top of interoperability standards is unclear. Increasing power generally increases the safety risk if components are faulty or standards are not met. We assess in this case that this additional risk negates any benefits from agreeing standards on interoperability.

In summary, the impact of all of the five policy options on product safety is expected to be small compared to the baseline, as none of the options specifically addresses this issue. We expect that the standardisation of cables may lead to increased opportunities for counterfeit or non-conforming (and unsafe) products to enter the market. It is also unclear what impact the mandated use of adaptors would have, but on balance we evaluate this to be slightly detrimental to product safety. Options 4 and 5, which address the EPS, may reduce product safety risks by harmonising interoperability of EPS across devices, but the minimum power requirements in option 5 could negate any benefits as higher power will exacerbate any safety issues in counterfeit or substandard chargers. Overall, and noting the paucity of evidence on which the assessment was based, we evaluate the option most likely to generate the most benefits to product safety for consumers is option 4.

Decoupling is the area where product safety would become most relevant. As noted previously (see section 5.1), all options have the potential to contribute to increased voluntary decoupling, to a greater or lesser extent, but their actual effects are highly uncertain. Should decoupling rates increase (which appears most likely under options 4 and 5), consumers, instead of passively receiving a new, safe and compliant charger with their new phone, would more frequently need to re-use an old or purchase a new charger themselves. The increase in the market for standalone chargers that would result from decoupling, would be expected to result in a proportional increase in the number of non-compliant and unsafe chargers entering the stock of chargers. It is possible there may be mitigating factors in this area following from such a policy change, for example phone manufacturers would likely still sell their own (OEM) chargers separately and dedicate more efforts to promoting these sales. A larger market could encourage more reputable manufacturers to enter and also encourage greater attention from product safety agencies. Nevertheless, there remain concerns from stakeholders such as national authorities that in a decoupling scenario large numbers of consumers would resort to internet searches and purchase the cheapest, not necessarily safe or compliant, chargers they can find, and that it would remain difficult for authorities to monitor and police these sales, leading to increased product safety risks.

Illicit markets

As discussed previously (see section 3.8), an unknown but potentially significant part of the market for standalone chargers is currently counterfeit ("fake"). It is inherently difficult to anticipate how this segment of the market would evolve under the various harmonisation options being assessed, as the nature and extent of such criminal activity is impossible to predict. Nonetheless, it is worth exploring if and how the different options and scenarios could alter the opportunities and/or incentives for the import and sale of counterfeit chargers in the EU.

Device-end connectors (options 1, 2 and 3)

The options to prescribe a common connector at the phone end (with or without the possibility of providing adaptors to comply) as such appear unlikely to have a significant effect on the illicit market compared with the baseline scenario (for very similar reasons to those discussed above under product safety impacts). The elimination of proprietary connectors in favour of USB Type-C would obviously eliminate the market for cables with fake Lightning connectors (which some
interviewed stakeholders argued is especially lucrative for criminals due to the relatively high retail prices Apple charges for its original accessories). However, there is no reason to expect this to lead to an overall reduction in the market for counterfeit cables, or to expect that genuine cables with USB Type-C connectors offered by Apple and other manufacturers in the future would be less expensive (and therefore offer fewer incentives to counterfeiters) than the range of cables that is currently available. On the other hand, it could also be argued that in a situation in which cables with USB Type-C connectors are increasingly ubiquitous, consumers would be more open to purchasing and using non-OEM cables (based on a greater awareness that cables from different brands are essentially “the same”), which would reduce the opportunities for counterfeiters (while potentially favoring cheaper non-branded products, as discussed in the previous section). However, this line of argumentation is highly speculative. In summary, there is no clear evidence, and no unambiguous rationale, to suggest that options 1, 2 or 3 would be likely to significantly reduce or increase the market for counterfeit charging cables.

**EPS (option 4 and 5)**

Similarly, mandatory requirements for EPS included in the box with mobile phones or sold separately by phone manufacturers, appear unlikely to alter the market for counterfeit chargers per se. On the one hand, minimum requirements that raise the bar for “standard” EPS, and therefore make them potentially more expensive, could be expected to increase demand for cheaper alternatives among consumers looking to purchase a standalone charger (e.g. because the one shipped with their phone was lost or damaged). However, the extent to which this demand would be met by counterfeit EPS, or by non-OEM / non-branded products, is impossible to predict. As outlined above, greater awareness of the common standards could reduce the importance consumers attach to the charger’s brand, and thus reduce the temptation to buy an apparently OEM (but actually fake) EPS, and cancel out some or all of the price incentive. On balance, in the absence of conclusive evidence, we assume the effect of both options 4 and 5 on the market for counterfeit EPS to be minimal.

**Decoupling**

An increase in the number of phones sold without chargers is expected to bring with it an increase in the sales of standalone chargers. This is expected to be smaller than the corresponding decrease in chargers shipped in the box with phones (since many consumers would re-use existing chargers rather than buy new standalone ones), but the higher decoupling scenarios could nonetheless lead to a significant increase in the market for standalone chargers. And even though the effect of the different options on the market share of counterfeit chargers is impossible to predict with certainty (due to the unclear and potentially counterbalancing incentives discussed above), growth in the market as a whole would be likely to also increase the illicit market (even if we assume that their share of the market remains unchanged).

In summary, there is nothing to suggest that any of the options as such would have a significant effect on the share of counterfeit products (cables and/or EPS) in the standalone charger market. However, there is a high risk that, if there was growth in this market as a whole (as a result of more decoupling), then a part of this larger market would be captured by counterfeiters.
5.3 Environmental impacts

The key environmental impacts were introduced in section 3.6 of this report, which set out the modelled impacts of the baseline scenario in terms of raw material use, e-waste, recycling and CO₂ emissions. The stock model has also been used to model the impacts of each policy option for each of these environmental impact categories. This has required a number of assumptions to be made on how each option leads to different evolutions of the charger stock. The key differences in assumptions are set out in Table 24 below.

Table 24: Summary of changes to the stock model compared to the baseline scenario

<table>
<thead>
<tr>
<th>Policy options for mobile phone chargers</th>
<th>Connectors at the device end</th>
<th>EPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. USB Type-C only</td>
<td>Assumes proprietary connectors are phased out from 2022, to zero by 2023</td>
<td>Guaranteed interoperability of EPS</td>
</tr>
<tr>
<td>2. USB Type-C only; for phones with proprietary receptacles, adaptors in the box compulsory</td>
<td>Assumes proprietary connectors are phased out from 2022, to zero by 2023</td>
<td>Interoperability plus minimum power requirements for EPS</td>
</tr>
<tr>
<td>3. USB Type-C or proprietary; for cables with proprietary connectors, adaptors in the box compulsory</td>
<td>Assumes that from 2023 adaptors from proprietary cable connectors to USB C (device side) are provided</td>
<td></td>
</tr>
<tr>
<td>4. Guaranteed interoperability of EPS</td>
<td>No difference is modelled due to insufficient data on current standard compliance</td>
<td>No difference is modelled as baseline scenario already envisages full switch to fast charging EPS</td>
</tr>
<tr>
<td>5. Interoperability plus minimum power requirements for EPS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on these assumptions the policy options were modelled. The key results for environmental impacts are presented in summary below. Note: this does not include any potential effects from the decoupling scenarios, these are presented at the end of this section.
Table 25: Summary of environmental impact of policy options

<table>
<thead>
<tr>
<th>Impact</th>
<th>Value</th>
<th>Baseline</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
<th>Option 4</th>
<th>Option 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material Use [tonnes]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 2023-2028</td>
<td>91 401</td>
<td>92 521</td>
<td>93 008</td>
<td>91 888</td>
<td>91 401</td>
<td>91 401</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>1 120</td>
<td>1 607</td>
<td>487</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Annual average</td>
<td>15 234</td>
<td>15 420</td>
<td>15 501</td>
<td>15 315</td>
<td>15 234</td>
<td>15 234</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>187</td>
<td>268</td>
<td>81</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>As %</td>
<td>1.2%</td>
<td>1.8%</td>
<td>0.5%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td><strong>E-waste [tonnes]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 2023-2028</td>
<td>74 528</td>
<td>74 737</td>
<td>74 808</td>
<td>74 600</td>
<td>74 528</td>
<td>74 528</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>208</td>
<td>280</td>
<td>72</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Annual average</td>
<td>12 421</td>
<td>12 456</td>
<td>12 468</td>
<td>12 433</td>
<td>12 421</td>
<td>12 421</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>35</td>
<td>47</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>As %</td>
<td>0.3%</td>
<td>0.4%</td>
<td>0.1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td><strong>Of which Recycled [tonnes]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 2023-2028</td>
<td>31 940</td>
<td>32 011</td>
<td>32 046</td>
<td>31 975</td>
<td>31 940</td>
<td>31 940</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>71</td>
<td>106</td>
<td>35</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Annual average</td>
<td>5 323</td>
<td>5 335</td>
<td>5 341</td>
<td>5 329</td>
<td>5 323</td>
<td>5 323</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>12</td>
<td>18</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>As %</td>
<td>0.2%</td>
<td>0.3%</td>
<td>0.1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td><strong>CO₂ emissions [ktonnes]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 2023-2028</td>
<td>5 409</td>
<td>5 443</td>
<td>5 457</td>
<td>5 423</td>
<td>5 409</td>
<td>5 409</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>34</td>
<td>48</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Annual average</td>
<td>901</td>
<td>907</td>
<td>910</td>
<td>904</td>
<td>901</td>
<td>901</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>6</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>As %</td>
<td>0.6%</td>
<td>0.9%</td>
<td>0.3%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

Raw material usage, e-waste and recycling

Raw material usage is influenced by the weight of the charger and its components. As the options influence the types of EPS and cables used in new chargers, they also influence the total raw material usage. As highlighted already in section 3.6, there is a trend towards heavier chargers as fast charging EPS technologies, which have more complex and heavier components gradually become the new standard. E-waste and recycling volumes are also strongly influenced by the
weight of the charger and its components, but with a more significant lag until changes in charger type are reflected in volumes of waste, due to the time in which the charger is in use, or stored out of use prior to actual disposal. The policy options mainly influence differences in the cable connectors, and the addition of adaptors compared to the baseline. The key differences can be summarised as follows.

**Option 1**

This option results in all chargers being supplied with cables ending in USB-C connectors at the device end. In practical terms this is modelled as a switch in the market share of cables with a USB C connector at the EPS end and a proprietary connector at the phone end (henceforth referred to as USB C – Proprietary), to cables with USB Type C connectors at both ends (USB C – USB C). The model assumes, based on reported and tested weights, that the USB C – USB C cables are slightly heavier than the proprietary cables.

Therefore we assess that this policy option leads to a small increases in raw material usage, e-waste and recycling volumes:

- Raw material usage is 1,120 tonnes higher than the baseline total between 2023-2028, or around 187 tonnes per year. This represents a 1.2% increase compared to the baseline. The material usage broken down in the stock model showed that around 51% of the material usage is plastics, 6% copper and the remainder a mix of other materials. The split between the EPS and cable material volumes is 69% EPS to 31% cable.

- E-waste is 208 tonnes higher than the baseline total between 2023-2028, or around 35 tonnes per year. This represents a 0.3% increase compared to the baseline.

- Recycling volumes also increase slightly to 71 tonnes higher than the baseline total between 2023-2028, or around 35 tonnes per year. This represents a 0.2% increase compared to the baseline.

**Option 2**

This option is the same as option 1, but allows for manufacturers to provide adapters from USB C to proprietary connectors. This therefore results in additional material use not only from the switch to the slightly heavier USB C cables, but also from the addition of adaptors. As the adaptors are only estimated to be small (weighing around 2g), the additional material usage is also only small as a % of the baseline and compared to option 1.

Therefore we assess that this policy option leads to a small increases in raw material usage, e-waste and recycling volumes:

- Raw material usage is 1,607 tonnes higher than the baseline total between 2023-2028, or around 268 tonnes per year. This represents a 1.8% increase compared to the baseline. The split between the component material volumes is almost the same as option 1 at 69% EPS, 30.5% to the cable and only 0.5% to the adaptors. The small volume from the adaptors means that there is no significant change to the material usage types noted in option 1.

- E-waste is 280 tonnes higher than the baseline total between 2023-2028, or around 47 tonnes per year. This represents a 0.4% increase compared to the baseline.
• Recycling volumes also increase slightly to 106 tonnes higher than the baseline total between 2023-2028, or around 18 tonnes per year. This represents a 0.3% increase compared to the baseline.

Option 3

This option is a hybrid of the first two options, allowing for the continued sale of proprietary cables, but with mandatory provision of adaptors to USB C. This avoids the additional material use from heavier USB C cables but still requires the additional material use of an adaptor. The former effect is greater than the latter, as a result of the very low weight of adaptors, and as a result this policy option leads to a smaller increase in material usage than the first two options.

We assess that this policy option leads to a small increases in raw material usage, e-waste and recycling volumes:

• Raw material usage is 487 tonnes higher than the baseline total between 2023-2028, or around 81 tonnes per year. This represents a 0.5% increase compared to the baseline. The split between the component material volumes is 69% EPS, 30.5% to the cable and only 0.5% to the adaptors. As a result there is no significant change to the material usage types as noted in option 1.

• E-waste is 72 tonnes higher than the baseline total between 2023-2028, or around 12 tonnes per year. This represents a 0.1% increase compared to the baseline.

• Recycling volumes also increase slightly to 35 tonnes higher than the baseline total between 2023-2028, or around 6 tonnes per year. This represents a 0.1% increase compared to the baseline.

Options 4 & 5

These options did not result in any variation from the baseline, as it was not possible to model the differences proposed by the options. In our opinion any changes from option 4 would be minimal, as this would largely reflect a change in protocols and standards, not of hardware and materials. Option 5 could lead to the use of heavier EPS to accommodate minimum power requirements, but it is unclear if and how these would exceed the baseline.

In summary, the changes in material consumption, e-waste and recycling, at less than 2%, are very low under every option. Option 4 appears to have no discernible environmental impacts. Of the options with impacts, option 3 is estimated to provide the least significant increases in raw material usage, e-waste and recycling compared to the baseline. Option 2, due to both requiring heavier cables and an adapter is the option which increases raw material consumption, e-waste and recycling the most.

CO₂ emissions

The GHG emissions impacts of chargers are a factor of both the weight and content of the different components of a charger. The key assumptions for these were presented in section 3.6, where profiles for component types were develop which provide emissions multipliers per g of weight for EPS, cables and adaptors. Combining these with the stock model assumptions, we have assessed the emissions impacts of the different options. These represent the full life-cycle emissions of the chargers sold each year under each option. The split of emissions between components remains quite constant across the options, with around 84% of the emissions attributable to the EPS and 16% to the cable. For the options using adapters the share of total emissions remains below 0.5%.
Option 1

The increased weight of USB C – USB C cables (compared to USB C – Proprietary cables) means that there are higher emissions associated with these cables resulting from emissions embedded in the materials used and the transportation of the finished charger to market. We assess that the GHG emissions of this policy option are 34 ktCO₂e higher than the baseline total between 2023-2028, or around 6 ktCO₂e per year. This represents a 0.6% increase compared to the baseline. For context the baseline emissions annual average of 901 ktCO₂e per year represents around 0.02% of EU28 total 2017 emissions of 4 483 100 ktCO₂e. Although every little helps the emissions impacts are quite small and particularly the differences compared to baseline.

Option 2

This addition of adaptors to this option, on top of the same changes as in option 1, means emissions are higher. We assess that the GHG emissions of this policy option are 48 ktCO₂e higher than the baseline total between 2023-2028, or around 8 ktCO₂e per year. This represents a 0.9% increase compared to the baseline.

Option 3

The use of lighter cables paired with adapters, and the former effect outweighing the latter, means that option 3 has lower emissions than options 1 and 2, although still higher than the baseline. We assess that the GHG emissions of this policy option are 15 ktCO₂e higher than the baseline total between 2023-2028, or around 2 ktCO₂e per year. This represents a 0.3% increase compared to the baseline.

Options 4 & 5

As explained above, these options did not result in any variation from the baseline, as it was not possible to model the differences proposed by the options. In our opinion any changes from option 4 would be minimal as this would largely reflect a change in protocols and standards, not of hardware and materials which would drive emissions impacts. Option 5 could lead to the use of heavier EPS to accommodate minimum power requirements, but it is unclear if and how the market share of these would exceed the baseline and therefore impact on emissions.

In summary, the increases in GHG emissions from the options are very low under every option, at less than 1%. As before, option 4 appears to have no discernible environmental impacts. Of the options with impacts, option 3 is estimated to provide the least significant increases in emissions compared to the baseline. Option 2, due to both requiring heavier cables and an adapter is the option which increases emissions the most.

Decoupling scenarios

As noted above, the environmental impacts of the proposed policy options are limited, namely because although they lead to small changes in the types of charges supplied to consumers, the total number of chargers remains the same. Supplying phones without a charger – decoupling the charger from the phone – is one way in which significant environmental impacts could be foreseen. Although outside the scope of our main policy options, we have also used the stock model to model the impact of the three decoupling scenarios – as applied to the baseline – that were introduced in section 5.1. These provide an indication of the potentially significant environmental benefits that decoupling could bring.
The results are shown in Table 26 below, these show significant impacts:

- Raw material use between 4-31% lower than in the baseline scenario, resulting in annual raw material savings of 590-4,750 tonnes.
- E-waste generation between 3-16% lower than in the baseline scenario, resulting in annual volume reductions of 330-1,980 tonnes.
- Recycling volumes decreasing by 3-16% compared to the baseline scenario, resulting in annual volume reductions of 140-860 tonnes.
- GHG emissions between 4-32% lower than in the baseline scenario, resulting in annual emissions reductions of 36-285 ktCO₂e.

<table>
<thead>
<tr>
<th>Impact</th>
<th>Value</th>
<th>Baseline</th>
<th>Decoupling Lower case scenario</th>
<th>Decoupling Medium case scenario</th>
<th>Decoupling High case scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak decoupling % (EPS)</td>
<td>0%</td>
<td>5%</td>
<td>15%</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>Material Use [tonnes]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 2023-2028</td>
<td>91,401</td>
<td>87,843</td>
<td>80,726</td>
<td>62,933</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>-3,558</td>
<td>-10,675</td>
<td>-28,468</td>
<td>-28,468</td>
<td></td>
</tr>
<tr>
<td>Annual average</td>
<td>15,234</td>
<td>14,640</td>
<td>13,454</td>
<td>10,489</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>-593</td>
<td>-1,779</td>
<td>-4,745</td>
<td>-4,745</td>
<td></td>
</tr>
<tr>
<td>As %</td>
<td>-3.9%</td>
<td>-11.7%</td>
<td>-31.1%</td>
<td>-31.1%</td>
<td></td>
</tr>
<tr>
<td>E-waste [tonnes]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 2023-2028</td>
<td>74,528</td>
<td>72,574</td>
<td>69,216</td>
<td>62,643</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>-1,955</td>
<td>-5,313</td>
<td>-11,885</td>
<td>-11,885</td>
<td></td>
</tr>
<tr>
<td>Annual average</td>
<td>12,421</td>
<td>12,096</td>
<td>11,536</td>
<td>10,441</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>-326</td>
<td>-885</td>
<td>-1,981</td>
<td>-1,981</td>
<td></td>
</tr>
<tr>
<td>As %</td>
<td>-2.6%</td>
<td>-7.1%</td>
<td>-15.9%</td>
<td>-15.9%</td>
<td></td>
</tr>
<tr>
<td>Of which Recycled [tonnes]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 2023-2028</td>
<td>31,940</td>
<td>31,093</td>
<td>29,639</td>
<td>26,796</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>-846</td>
<td>-2,300</td>
<td>-5,144</td>
<td>-5,144</td>
<td></td>
</tr>
<tr>
<td>Annual average</td>
<td>5,323</td>
<td>5,182</td>
<td>4,940</td>
<td>4,466</td>
<td></td>
</tr>
<tr>
<td>Difference with baseline</td>
<td>-141</td>
<td>-383</td>
<td>-857</td>
<td>-857</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Value</td>
<td>Baseline</td>
<td>Decoupling Lower case scenario</td>
<td>Decoupling Medium case scenario</td>
<td>Decoupling High case scenario</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------</td>
<td>----------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>CO₂ emissions</td>
<td>Total 2023-2028</td>
<td>5 409</td>
<td>5 195</td>
<td>4 768</td>
<td>3 701</td>
</tr>
<tr>
<td></td>
<td>Difference with baseline</td>
<td>-213</td>
<td>-640</td>
<td>-1 708</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annual average</td>
<td>901</td>
<td>866</td>
<td>795</td>
<td>617</td>
</tr>
<tr>
<td></td>
<td>Difference with baseline</td>
<td>-36</td>
<td>-107</td>
<td>-285</td>
<td></td>
</tr>
<tr>
<td></td>
<td>As %</td>
<td></td>
<td>-2.6%</td>
<td>-7.2%</td>
<td>-16.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-3.9%</td>
<td>-11.8%</td>
<td>-31.6%</td>
</tr>
</tbody>
</table>

The contrast of the significant results under the higher decoupling scenarios, with the very limited impacts of the policy options as such, highlights the fact that the initiative as currently conceived could only be expected to have significant environmental benefits if the harmonisation of charger components led to greater decoupling. As discussed previously (see section 5.1), the extent to which this would happen on a voluntary basis is highly uncertain, but the potential appears highest under options 4 and 5, especially if combined with option 1.
5.4 Economic impacts

This section assesses the key economic impacts for key stakeholders, including industry, consumers and public authorities, under each policy option. These include an estimation of the financial costs for the main affected groups, and of the potential impacts on innovation. Where possible, costs and benefits are quantified in monetary terms. In other cases, a qualitative assessment is provided.

Costs (for economic operators and consumers)

To calculate the financial costs of the different options, we have built a framework that identifies types of cost per stakeholder involved. Then, assumptions are made on the types of costs that are relevant/significant and on who bears the cost. We have identified the following relevant types of costs:

- **Production costs**: The policy options require the use of certain EPS and/or connectors. In the first instance, in the absence of decoupling, we assume such an EPS and/or connector will be included in the box with each phone sold. The costs and prices of different solutions differ (production costs, wholesale price and retail price). Our assumption is that differences in costs will be passed on to consumers, and that the margin gained by the industry (charger producers, distributors and phone manufacturers) will be similar for all types of chargers. Differences in revenue for the industry (charger manufacturers), hence, will mostly depend on quantities sold. Therefore, the significance of these costs will mainly depend on the decoupling scenarios.

  In interviews, phone manufacturers commented that they typically do not make any margin from the inclusion of EPS and cables in the box, and that this is mainly included to ensure consumer satisfaction, safety and interoperability. Therefore, our model assumes that differences in cost for consumers will be similar to differences in wholesale prices of different charging solutions.

- **Adaptation costs**: It is expected that manufacturers producing/providing proprietary charging solutions in the box will have to adapt their production lines and/or packaging to standard solutions with some options (options 1, 4 and 5). This cost is not expected to be directly passed on to consumers in the short term, and therefore we assume that it is born by the industry. This cost is assessed qualitatively in our model.

- **Certification costs**: Options 4 and 5 imply that producers will need to go through a certification process for the EPS they produce/include in the box, to ensure compliance with the relevant standards. The cost of certification is expected to be passed on to consumers. On the other hand, authorities would also need to control these chargers, which would increase control costs. Revenues for public authorities from the certification process are expected to cover the costs of the process, but not the costs of controlling the market. Costs of certification are assessed qualitatively.

- **Royalties**: Finally, manufacturers of proprietary solutions may lose the income generated by royalties. We assume that this cost is currently born by consumers, and it is included in the wholesale price of chargers.

Table 33 below includes our assumptions on how costs are distributed among the different stakeholders, for each policy option. The table also indicates whether these stakeholders are located in the EU or elsewhere.
<table>
<thead>
<tr>
<th>Effect / stakeholder</th>
<th>Charger manufacturers</th>
<th>Mobile phone manufacturers (proprietary solutions)</th>
<th>Mobile phone manufacturers (USB)</th>
<th>Consumers (economic cost only)</th>
<th>Public authorities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location:</strong> EU / Rest of the world (ROW)</td>
<td>ROW (minority in EU, only HQ)</td>
<td>ROW</td>
<td>EU (minority) and ROW</td>
<td>EU</td>
<td>EU</td>
</tr>
<tr>
<td><strong>Option 1</strong> (USB C only at device end)</td>
<td>• Manufacturers of accessories for proprietary solutions lose competitive advantage. Potential market share gained by other manufacturers. Net effect: 0.</td>
<td>• Cost of re-designing old phones with USB C or foregone income from selling these devices if removed from the market. • Cost of designing new phones with USB C.</td>
<td>• No effect (no additional cost for re-designing phones that currently use USB micro-B connectors to USB C as we assume the transition will have occurred by 2023 even under the baseline scenario).</td>
<td>• Difference in cost between USB micro-B or proprietary and USB C (assumed cost passed through to consumers).</td>
<td>• No impact</td>
</tr>
<tr>
<td><strong>Option 2</strong> (USB C + adaptor)</td>
<td>• Increased income from selling adaptors</td>
<td>• No effect (cost of including adaptors passed through to consumers).</td>
<td>• No effect (cost of including adaptors passed through to consumers).</td>
<td>• Cost of adaptors (assumed it is passed on to consumers).</td>
<td>• Difference in cost USB C cable vs other cables.</td>
</tr>
<tr>
<td><strong>Option 3</strong> (any cable + adaptor to USB C)</td>
<td>• Increased income from selling adaptors</td>
<td>• No effect (cost of including adaptors passed through to consumers).</td>
<td>• No effect (cost of including adaptors passed through to consumers).</td>
<td>• Cost of adaptors (assumed it is passed on to consumers).</td>
<td>• No impact</td>
</tr>
<tr>
<td><strong>Option 4</strong> (guaranteed interoperability)</td>
<td>• Decrease in sales in lower end chargers in favour of higher end chargers - net effect of margins/quantity.</td>
<td>• No effect</td>
<td>• Rear the cost of certification • Rear the cost of certification • Rear the cost of certification</td>
<td>• Rear the cost of certification • Rear the cost of certification</td>
<td>• Cost of controlling compliance</td>
</tr>
<tr>
<td><strong>Option 5</strong> (Minimum charging performance)</td>
<td>• Decrease in sales in lower end chargers in favour of higher end chargers - net effect of margins/quantity.</td>
<td>• Design cost of upgrading models at least to 15W</td>
<td>• Rear the cost of certification • Rear the cost of certification • Rear the cost of certification</td>
<td>• Rear the cost of certification • Rear the cost of certification</td>
<td>• Cost of controlling compliance</td>
</tr>
</tbody>
</table>
The most significant costs are the adaptation cost, especially for those manufacturers currently using proprietary connectors, and the production cost. The latter is due to the differences in quantities and prices of each type of EPS/cable that consumers would buy in the box. As explained above, we have assumed phone manufacturers do not make any margin from including chargers in the box, as per the information provided during the interviews, and that therefore the cost for consumers is similar to the wholesale price of the EPS and cables. Based on information provided by interviewees and on our own market research on online wholesale sites, we have estimated the following wholesale prices per item:

Table 28: Cost per item (EPS, cable and connectors)

<table>
<thead>
<tr>
<th>Item</th>
<th>Type of item (1)</th>
<th>Wholesale price (EUR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPS - USB A</td>
<td>USB A - Standard charger</td>
<td>5</td>
</tr>
<tr>
<td>EPS - USB A</td>
<td>USB A - Fast charger - USB-PD</td>
<td>8</td>
</tr>
<tr>
<td>EPS - USB A</td>
<td>USB A - Fast charger - proprietary</td>
<td>3.5</td>
</tr>
<tr>
<td>EPS - USB C</td>
<td>USB C - Fast charger - USB-PD</td>
<td>12</td>
</tr>
<tr>
<td>EPS - USB C</td>
<td>USB C - Fast charger - proprietary</td>
<td>15</td>
</tr>
<tr>
<td>Cables (1m)</td>
<td>USB A - USB Micro B</td>
<td>0.5</td>
</tr>
<tr>
<td>Cables (1m)</td>
<td>USB A - USB C</td>
<td>0.9</td>
</tr>
<tr>
<td>Cables (1m)</td>
<td>USB A - proprietary</td>
<td>0.7</td>
</tr>
<tr>
<td>Cables (1m)</td>
<td>USB C - USB C</td>
<td>1.5</td>
</tr>
<tr>
<td>Cables (1m)</td>
<td>USB C - proprietary</td>
<td>2</td>
</tr>
<tr>
<td>Adapter</td>
<td>Adapter USB Micro B - USB C</td>
<td>0.5</td>
</tr>
<tr>
<td>Adapter</td>
<td>Adapter Proprietary - USB Micro B</td>
<td>0.5</td>
</tr>
<tr>
<td>Adapter</td>
<td>Adapter Proprietary - USB C</td>
<td>0.5</td>
</tr>
<tr>
<td>Adapter</td>
<td>Adapter USB A - USB C</td>
<td>0.5</td>
</tr>
</tbody>
</table>

(1) Fast charger assumes 15W.

It has not been possible in this study to collect information on margins gained by charger manufacturers per type of charger. Therefore, we have assessed costs and benefits qualitatively, based on changes in quantities of chargers produced and sold to be included in the box. It is expected, therefore, that the main changes in surplus for charger manufacturers will be due to decoupling, rather than to the policy options per se.

Our assessment of economic impacts per policy option and stakeholder is summarised in the table below.

Table 29: Assessment of economic impacts per policy option

<table>
<thead>
<tr>
<th>Connectors at the device end</th>
<th>EPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of cost and stakeholders affected</td>
<td>Option 1</td>
</tr>
</tbody>
</table>
As explained above, however, main changes would be expected with decoupling. In section 5.1 we built three different scenarios for decoupling: low, middle and high, all of them with decoupling rates above the baseline. With decoupling, the surplus gained by consumers from savings of not buying chargers in the box would be a detriment for producers, who would have foregone incomes from not selling those chargers. Again, we have calculated production costs using wholesale prices. The table below show the difference in price that consumers would pay for their mobile phone chargers included in the box. It compares the price of the charging solution included in the box in two different scenarios: the baseline and a decoupling scenario (low, mid or high).

Table 30: Economic impacts of decoupling

<table>
<thead>
<tr>
<th></th>
<th>Low decoupling scenario</th>
<th>Mid decoupling scenario</th>
<th>High decoupling scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savings for consumers (and foregone income for producers), 2020-2028</td>
<td>493 million Euros (4% of price of chargers in baseline)</td>
<td>1,479 million Euros (12% of price of chargers in baseline)</td>
<td>3,944 million Euros (32% of price of chargers in baseline)</td>
</tr>
</tbody>
</table>

It should be noted that our model is subject to the following limitations:

* Values expressed in Net Present Value for the period 2020-2028, using 2020 as base year, and a discount rate of 4% per year, as per the Better Regulation Toolbox (Tool #61)
- Production costs for the different charging solutions (EPS and cables) have been kept constant over time. While this is a reasonable assumption, given the uncertain evaluation of prices, it may overestimate the costs of new solutions (such as USB Type-C connectors), as these are expected to reduce over time.

- Costs (foregone income) or savings of products sold separately (i.e. not included in the box) are not included in our model. Our decoupling scenarios already account for saturation (i.e. assume consumers would not need additional components), and therefore these costs or savings are not expected to be significant. This, however, has some implications:
  - In options 1, 2 and 3, however, it is expected that consumers will buy fewer adaptors from proprietary solutions to USB (bought separately), which means that our model may underestimate consumers’ savings.
  - Currently, phone manufacturers using proprietary solutions receive royalties when proprietary chargers (cables) are sold separately. These revenues are not included in our model.

- Costs or savings for distributors are not included, as these are not expected to be significant for charging solutions included in the box.

- There are other industrial sectors that are not included in our framework, such as chip manufacturers, who may experience loss of income under certain policy options. However, we believe the effects derived from the policy options are not significant (e.g. sales of EPS using proprietary solutions might decrease in Options 4 and 5, but most EPS with proprietary solutions, such as Quick Charge, are already interoperable with USB standards).

- Our model only accounts for net effects. There may, however, be redistribution of sales/income among different industry stakeholders.

In summary, the economic costs depend largely on the decoupling rates, rather than the policy options on connectors or type of EPS. Increased decoupling could result in potentially significant savings for consumers of up to €3.9 billion over the duration of the period considered (2023-2028) in the high decoupling scenario (which is approximately equivalent to a 1.1% reduction in the average price of mobile phones).62

Among the options that consider different types of connectors and adaptors, Option 1 is the best option for consumers, who would accrue small savings, as they would not have to pay for additional connectors in the box, and cables USB C to USB C have lower cost than USB C to Lightning. Our model assumes constant wholesale prices, and therefore results may vary slightly if USB C to Lightning were to become cheaper (the savings would disappear entirely if the cost of Lightning and USB C cables were identical). The current difference observed in the cost may be due to two different elements: a) the proprietary costs of Lightning, and b) the fact that USB C to Lightning has been introduced to the market after USB C to C.

Option 1, however, is the least favourable for the industry, and in particular for manufacturers of mobile phones using proprietary solutions. The adaptation cost for these manufacturers is expected to be high, as current models would need to be redesigned or removed from the EU market. It should be noted that these manufacturers are based outside of the

62 Average savings per year, assuming total value of mobile phones sold in the EU remains constant at 2018 levels (60 billion Euros per year) between 2023 and 2028.
EU. This option would also impact the suppliers of phone manufacturers using proprietary solutions, who may lose part of the market share against other competitors. This would only have redistribution effects among charger suppliers.

Option 2 presents some savings for consumers due to the difference in price between cables using Lightning and USB C, but this is mostly offset by the inclusion of adaptors, that raise the total price. This option has minor adaptation costs for the industry.

Option 3 is the least favourable for consumers, in terms of economic cost only. The slightly higher price they would have to pay, as compared with the baseline, is due to the higher cost of Lightning vs USB C and the inclusion of adaptors in the box. This option would have negligible cost impacts for the industry.

The options that consider the EPS have very little impact on any stakeholder other than public authorities. This is because the inputs in our stock model for these options hardly differ from the baseline, given the trend towards interoperable EPS in the market anyways. Under Option 5 all EPS will provide over 15W, and therefore the cost for consumers is expected to be very slightly higher than in the baseline. It should be noted that this option may generate adaptation costs for manufacturers of low-end mobile phones, who would need to move towards USB PD a bit faster than the current pace (the baseline). Some of these manufacturers are headquartered in the EU (e.g. BQ, Fairphone). Both option 4 and 5 include a cost for public authorities for controlling EPS, which may be relatively significant.

Innovation

One of the main concerns related to harmonising mobile phone chargers, highlighted by the industry and some consumers, is the potential impact on innovation. As explained in Section 3.7, an obligatory regulation (vs. a voluntary approach) may decrease investment flows towards R&D projects developing new charging solutions.

There are many interplaying elements in charging solutions: materials used, chemistry, current and voltage applied, type of connectors, etc. Manufacturers often use different combinations of these elements to match the charging profile and the shape of their device. A strict regulation (i.e. mandating for specific power and components), industry warns, would impede them innovating with these elements.

Our policy options affect two main elements of the charger, which would affect innovation in very different ways: a) the connector at the device end (Options 1, 2 and 3) and b) the use of certain standards (option 4) and minimum power requirements (option 5) for the EPS. The remainder of this sub-section discusses the effects on innovation for each of these elements (and their options).

Options 1, 2 and 3 affect the connector between the cable assembly and the device. Under option 1, proprietary connectors of any sort would be banned. Options 2 and 3, however, allow mobile phones to use proprietary connectors, while mandating the inclusion of adaptors. These two options, therefore, are not expected to impact innovation on the type of connector given that they provide enough flexibility to manufacturers to use proprietary solutions. In addition, they would always have the possibility of selling phones without chargers (decoupling) if they would prefer not to include adaptors in the box.

If only USB Type C is allowed at the phone end, manufacturers would no longer have an incentive to invest in the development of proprietary connectors that might give them an advantage over their competitors (and therefore result in
potentially significant economic returns from their investment). Instead, future innovation would largely be limited to
efforts by the industry as a whole (coordinated via the USB Implementers’ Forum) to update or improve the current USB
Type C technology, or to eventually replace it with a new generation of common USB connectors. In other words,
innovation would still be possible (and indeed, likely to occur), but the rewards of any improved technology would be
shared by the sector as a whole. There is a risk that this would slow the pace of innovation overall, and make ground­
breaking or “game-changing” innovations outside of the USB framework less likely. The actual significance of this effect is
impossible to predict (or even quantify) with any degree of certainty, since we cannot predict what the next innovation
would be, what it would look like, and what advantages it would bring. However, to illustrate the potential, we may look at
the past for reference. 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.

In addition, industry argues that other elements of the phone might also be affected. In theory, future proprietary
solutions could be smaller or have a different shape, thus making possible, for instance, thinner devices.

Overall, manufacturers agreed that they have a single production line, and would only consider selling phones with
different types of connectors in different parts of the world as a last resort (if at all). Therefore, according to industry, such
a regulation in the EU would be likely to affect their innovation activities worldwide.

One could argue that innovative (non USB) connectors could still be developed for those devices that do not fall within
the scope of the initiative (assuming that this remains limited to mobile phones). Nonetheless, manufacturers of other
devices who were consulted for this study explained that innovation normally happens in mobile phones first, and they
adopt those innovations later. While this is a route for innovation, it is not as significant as the investments made in mobile
phones.

In summary, Option 1 could potentially have a major negative effect in terms of reducing future innovation in phone
connectors, both by effectively ruling out any new “game-changing” proprietary connector technology, and by potentially
reducing the pace of “incremental” innovation as regards future generations of USB connectors, and limiting the
characteristics that this future connector might have. Nonetheless, this needs to be seen in the context of the baseline. In
practice, only one company is currently selling phones in the EU that do not use USB connectors, and even this company
has started using USB Type-C connectors in some of its other devices (such as tablets), which makes it seem unlikely it is
investing heavily (or sees major potential) in developing a new generation of proprietary connectors. Furthermore, there
are no indications that any other company is planning to stop using USB connectors (despite the migration from USB
micro-B to USB C). Therefore, overall, we conclude that Option 1 would only have a minor constraining impact on
innovation.

Options 4 and 5 focus on the EPS, requiring interoperability standards and, in the case of Option 5, minimum power of
15W. The impact of standardisation on innovation has been widely explored in the literature. One of the effects is that
standards (international ones in particular) in theory limit companies’ freedom of choice.

The Community Innovation Survey in the EU collects data on innovation activities in enterprises, in both products and
processes. The survey explores the effects of legislation and regulation for innovative enterprises, by type of effect. The
last published results are from 2016, and they show that around a fourth of companies which have innovation as its core
activity experience at least one negative effect due to legislation or regulation. The most frequent effect is "increase of the costs of one or more innovation activities" (26%), followed by "initiation of one or more innovation activities" (22%).

<table>
<thead>
<tr>
<th>Effect</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop of one or more ongoing innovation activities</td>
<td>15%</td>
</tr>
<tr>
<td>Preclusion of starting one or more activities</td>
<td>22%</td>
</tr>
<tr>
<td>Initiation of one or more innovation activities</td>
<td>22%</td>
</tr>
<tr>
<td>Increase of the costs of one or more innovation activities</td>
<td>26%</td>
</tr>
<tr>
<td>Delay in the completion of one or more innovation activities</td>
<td>20%</td>
</tr>
</tbody>
</table>

Source: EU Community Innovation Survey (2016)

However, the evidence shows that the innovation-standardisation relationship can also be close, dynamic and productive, with standardisation playing different roles (positive or negative) at different stages of an innovation. ISUG (2002) Study into the impact of standardisation, Final Report to DG Enterprise

![Figure 28. Network externalities](source: Ipsos based on ISUG (2002))

ISUG argues that the impact of standardisation may be positive or negative, depending on multiple factors including the stage of technology in which the standard arises (commencement, development or commercialisation). In this case, however, options 4 and 5 do not propose creating a new standard, but using a standard that is already in place and that has been created by the industry in cooperation (i.e. a network, such as the USB IF). Companies need standards that provide sufficient guidance to ensure compatibility and allow for technology transfer. However, standards that not only state what performance is required, but prescribe how it should be attained (specifying certain technologies or materials etc.) can inhibit innovation.

In our view, Option 4 is unlikely to affect innovation in a major way. The interoperability standards proposed for Option 4 have been described by the industry as "flexible" and have been developed following a participatory approach with

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63 ISUG (2002) Study into the impact of standardisation, Final Report to DG Enterprise

64 Ibid.
representatives from across different sectors in the industry (from chip manufacturers to manufacturers of mobile phones and other devices). The 62680 standard series defines interoperability standards, allowing industry to innovate on other aspects of the charger, and it does not prescribe specific materials or minimum voltage or current, for instance. In fact, some proprietary solutions, such as Quick Charge v4, incorporate a functionality that ensure interoperability, demonstrating that proprietary solutions would still be possible. However, any new or updated charging solution developed and used in mobile phone EPS in future would have to be compatible with USB Type-C and USB PD. Thus, this Option may further boost the existing trend of convergence towards interoperable solutions. At the same time, it does effectively rule out any potential innovations in the field of fast charging that are not interoperable with USB PD. This does represent a restriction on company's freedom to innovate, even though the effect in practice appears likely to be very limited in light of the way the market is evolving at present, and companies' own interest in ensuring interoperability.

Option 5 follows essentially the same logic, but is a little more restrictive since it specifies minimum wattage. Although the current trend in the market is to produce phones with greater capacity, requiring more power, there might be a segment of consumers willing to buy smaller, more simple phones that do not need 15W as a minimum. This Option, hence, may preclude innovation in smaller batteries requiring less power.

Therefore, we conclude that the impact on innovation for each policy option is as follows:

<table>
<thead>
<tr>
<th>Option</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td>(Minor negative impact on innovation for connectors)</td>
</tr>
<tr>
<td>Option 2</td>
<td>0 (Impact is negligible)</td>
</tr>
<tr>
<td>Option 3</td>
<td>0 (Impact is negligible)</td>
</tr>
<tr>
<td>Option 4</td>
<td>(Minor negative impact on innovation for fast charging technologies that are not based on / compatible with USB PD)</td>
</tr>
<tr>
<td>Option 5</td>
<td>(as option 4, plus minor negative impact on innovation for smaller batteries/devices)</td>
</tr>
</tbody>
</table>
5.5 Considerations for implementation

This section discusses key issues related to the potential implementation of the policy options defined previously (see chapter 4), including any significant risks, concerns or question marks about their feasibility from a technical point of view and the extent to which they would be acceptable to key stakeholders. In addition, it addresses the potential for extending the scope to other portable electronic devices and the likely indirect impacts on these, as well as the question of the possible policy instruments (voluntary or legislative) to implement each option. Since many of these elements primarily on the part of the charging solution that is being harmonised, the section starts by discussing the connectors at the device end (options 1, 2 and 3), before considering the external power supply (options 4 and 5).

Connectors at the device end

Technical feasibility

In principle, defining USB Type-C as the common connector between all mobile phones and the charging cable assembly (option 1) appears entirely feasible from a technical point of view. USB Type-C is now a relatively mature technology backed by an international standard (IEC 62680-1-3) that was first published in 2016, and has undergone two revisions since. There are no doubts it provides a high-quality charging (as well as data transfer) solution for mobile phones, and the fact that (in combination with USB PD) it is capable of providing up to 100W of power leaves ample room for further development of fast charging solutions.

The only significant concern in this respect is precisely the fact that USB Type-C is already at such a relatively mature stage of its likely life cycle. By 2023, when we assume any new rules would come into force (see section 4.2), our projections (based on recent trends) suggest that USB Type-C will have completely replaced USB micro-B connectors in mobile phones for sale on the EU market. While there are currently no concrete indications of a possible successor to USB Type-C, it appears likely that a new generation of connectors will begin to appear around the mid-2020s, if not sooner. This may limit the practical usefulness (and some of the positive impacts) of any attempts to prescribe USB Type-C as the common connector, and means provisions for an eventual shift to a possible successor technology need to be duly considered when pursuing this option (for further thoughts on this see below).

There are also no technical obstacles as such to making adaptors in the box mandatory for manufacturers that choose to continue to use proprietary receptacles in their phones (options 2 and 3). Such adaptors are already available for purchase on the market, and there is anecdotal evidence that some manufacturers have in the past included adaptors with their phones in other parts of the world. However, there are concerns around certain unintended negative impacts from this (see the previous sections) and their acceptability to manufacturers and consumers (see below).

Acceptability

Based on the responses to the public consultation, option 1 would be popular among EU citizens, with 76% responding they would be satisfied with a single standard connector on the phone end (and 77% with single standard connectors on both ends). However, adaptors to enable the use of different charger types with different mobile phones (as in options 2 and 3) were viewed far less favourably, with only 25% stating they would be satisfied with this course of action. Civil society (including consumer) organisations also tend to favour the highest possible degree of harmonisation.
The views among industry of a mandatory adoption of USB Type-C connectors in phones diverged (see also section 3.7). The majority of mobile phone manufacturers and other industry stakeholders consulted were not opposed to USB Type-C as the common device-end connector, and some were actively in favour of any move in this direction. On the other hand, a minority of industry players was strongly opposed to this, claiming it would limit their ability to offer customers with the best technical and design solution in each specific case. In any case, even among those in favour of harmonising connectors, there was a strong preference for achieving this via a voluntary approach, due to the widely held concerns among industry of how regulation would constrain future innovation.

As regards the use of mandatory adaptors, most industry representatives consulted were wary of the idea of obliging companies to include an additional component that not all customers may need, but would still have to pay for. Option 2 in particular would be subject to strong opposition from Apple, as in the current circumstances (and assuming it chooses to continue to use proprietary connectors after the new rules come into force) it would oblige the company to ship its phones with a cable that cannot be used to charge the phone it accompanies without the adaptor. On the other hand, it appears Apple might be willing to accept option 3 as a compromise solution.

**Potential to extend the scope to chargers for other portable electronic devices**

From a technical perspective, there are no obvious reasons why USB Type-C connectors at the device end could not be used for all common portable electronic devices, including devices with a charging profile that is similar to mobile phones, such as tablets or wearables, but also those with significantly higher power requirements, seeing as (in combination with USB PD) USB Type-C is capable of delivering up to 100W of power. In fact, our analysis (see section 3.4) shows that a small but growing number of devices, even including laptops, already include USB Type-C receptacles and the corresponding cables.

However, making the use of USB Type-C connectors mandatory for chargers of devices beyond mobile phones would give rise to a number of issues and concerns, the most significant of which can be summarised as follows:

- **Cost**: USB Type-C receptacles, connectors and cables incorporate more advanced technical features and materials than many other technologies (incl. earlier generations of USB), and are therefore more expensive to produce. For devices with a low value, and/or that do not require data transfer or other advanced functionalities, industry stakeholders argue that the additional cost would be difficult to justify.

- **Specific types of devices**: There are certain portable electronic devices with specific requirements as regards charging, be it because of their very small size or other design features (e.g. smart watches, hearing aids, etc.), the conditions in which they operate (e.g. underwater cameras, or devices that need to be able to withstand extreme temperatures, such as certain drones), or for other reasons. For some such devices, USB Type-C connectors would not be practical or even feasible. Arguably, a mandatory requirement to use them could also constrain the future development of other innovative types of devices.

- **Scope**: To the best of our knowledge, there is no widely accepted definition of what constitutes a “portable electronic device”. Therefore, the scope of any attempt to harmonise chargers for such devices would need to be considered very carefully in order to provide legal certainty, as well as exclude devices for which a common charger would not be appropriate (for the reasons outlined above or any others).

Even if the scope of application of the mandatory USB Type-C connectors remained limited to mobile phones only, it is worth considering possible indirect effects of this on the markets for other portable devices. As noted previously, the fact
that such a high proportion of consumers own a mobile phone means they tend to have a certain amount of influence on
the market for other devices; for example, the decision of some manufacturers to ship their e-readers, wearables or digital
cameras without a complete charging solution (usually with a cable, but without an EPS) is partly motivated by the
assumption that nearly all consumers own and are able to use their mobile phone chargers. Therefore, the adoption of a
common connector across all mobile phones could be expected to also contribute to a greater and/or faster adoption of
this in other electronic devices in which this makes technological, practical and commercial sense (keeping in mind the
constraining factors listed above). It could thus reinforce the existing trend of a gradual increase in the take-up of USB
Type-C technology and standards, although the extent of this is impossible to predict with any certainty. Nonetheless, it
seems clear that, from a wider "ecosystem" perspective, there are obvious benefits from convergence towards widely-used
standards, and there is no reason to believe the market for portable electronic devices (other than mobile phones) would
take a different direction.

Consideration of policy instrument

In principle, it would be possible to achieve the desired outcome – namely the exclusive use of USB Type-C connectors in
all mobile phones (softened somewhat by the possibility to provide adaptors under options 2 and 3) – via a voluntary
commitment by the industry. The 2009 MoU, which was signed by all major mobile phone manufacturers at the time,
included a similar commitment. However, despite intense exchanges and negotiations over the last several years, industry
has so far been unable to agree on a position that would go as far as any of the options considered here. In view of the
strong opposition from at least one key player (Apple), it seems unlikely at the present time that options 1 or 2 could form
part of a renewed voluntary agreement. This appears more achievable for option 3, which many manufacturers might
view as a suboptimal but nonetheless acceptable compromise solution.

If a voluntary commitment to any of the three options were achieved, one would need to pay close attention to the
details, in order to determine the extent to which its effects in practice would be identical (or at least similar) to the
equivalent regulatory measures. Elements that would require in-depth scrutiny include in particular:

- **Signatories:** Unless signed by all the major manufacturers, the effects of a voluntary agreement would be in
doubt. It should be noted that the 2018 MoU proposed by the industry was only signed by seven companies,
including the top two in terms of market share, but not number three.

- **Product scope and timeframe:** As noted previously (see section 4.2), we have based our analysis on the
assumption that any new rules would apply to all mobile phones sold on the EU market from 1 January 2023. By
contrast, the 2018 MoU would only apply to new Smartphone models introduced to the EU market beginning no
later than three years from the date of signing. Whether or not existing models need to comply with the new
rules after their entry into force could make a significant difference to the scale of their effects in the first years.

- **Mechanisms to ensure compliance:** The 2014 RPA study found that compliance rates with the 2009 MoU were
very high. However, it would need to be considered carefully to what extent a new voluntary agreement would
provide guarantees of compliance, and/or mechanisms to detect and penalise non-compliance. Any possible
"innovation" clauses would require particular scrutiny, as they might provide a way for signatories to opt out of
the commitments they made in case of having developed new (proprietary) connectors.
Possible legal basis

If it were to be determined that regulatory action is required, the question of the legal basis for this arises. While the study team is not in a position (or qualified) to provide a definitive or comprehensive legal analysis, a few observations on this appear pertinent. The most obvious candidate for the legal basis would be the Radio Equipment Directive 2014/53/EU (RED). Article 3 (3) of the RED empowers 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). As such, it appears relatively clear that a delegated act could be used to operationalise the requirement for mobile phones to work with common chargers. However, the power conferred upon the Commission by Article 3 (3) of the RED is widely acknowledged to be quite imprecise, and as a result, uncertainty remains as to, for example, what constitutes a “charger” in the sense of the Directive, i.e. which parts of radio equipment are needed to charge a mobile phone. More specifically, considering options 1, 2 and 3 as defined for this study, the RED refers to how “radio equipment” is “constructed”, which means it could almost certainly be used to regulate the receptacles on the phone itself. However, whether the corresponding cable assembly including the connectors could also be regulated appears more doubtful, and would require careful legal analysis in order to minimise the risk of legal uncertainty and potentially litigation.

Other issues that would need to be given due consideration when designing a regulatory proposal concerning common connectors for mobile phones include:

- **Technological neutrality and non-discrimination**: Prescribing a specific technology (in this case, USB Type-C) could give rise to legal challenge, given that the WTO Agreement on Technical Barriers to Trade (TBT) stipulates that technical regulations shall not be discriminatory or create unnecessary obstacles to trade.

- **Reviews / updates**: In order not to preclude future innovation, a regulatory initiative would have to enable an eventual transition to a possible successor to the USB Type-C technology. For this purpose, adequate review mechanisms would need to be incorporated.

- **Adaptors**: As noted above, and pending further legal analysis, it appears a delegated act under the RED could mandate a common receptacle on the phone itself, but not necessarily the corresponding cable assembly and connectors. This means that it is unclear whether mandatory adaptors “in the box” (as required under options 2 and 3) would fall within its scope.

Should it be determined that some or all of these issues cannot be satisfactorily addressed via a delegated act under the RED, the Commission would have to consider a revision of the RED itself, or an alternative legal basis.

External power supply

Technical feasibility

From a purely technical point of view, option 4, i.e. the requirement for all EPS to comply with the relevant standards for USB Type-C and (for those that provide more than 15W of power) USB PD does not give rise to any significant feasibility concerns. Many EPS that are supplied along with mobile phones already comply with these. The same is true of option 5: requiring all EPS shipped with mobile phones to provide at least 15W of power is undoubtedly technically feasible.
However, there are some question marks about how compliance with the relevant standards would be monitored and enforced. This would require an additional external certification process which EPS do not currently have to undergo (similar to existing safety certification tests), and would obviously imply additional costs for the companies in question. In the case of IEC 63002, which defines interoperability guidelines for EPS, there is also a question about the extent to which compliance with such guidelines could or should be enforced, though this potential obstacle could disappear if and when IEC 63002 is revised and more specific requirements added to it.

Another issue that would need to be considered carefully in relation to both options 4 and 5 is that presumably, the new rules and requirements would only apply to EPS sold "in the box" together with mobile phones. Obliging these to comply with certain standards (and potentially provide at least 15W of power) would essentially "pull" all such EPS towards what is currently the higher end of the scale in terms of technical specifications. While this would make no significant practical difference for higher-end devices, it would increase the price of lower-end phones, which would have to include a "better" charger than they might require. This could have an indirect effect in terms of encouraging higher decoupling rates for lower-end phones, as manufacturers might choose not to include an EPS in order to be able to offer a lower price. But this in turn could lead to an entirely different kind of issue: the high standards, and hence relatively high price, of "compliant" chargers could make cheaper, sub-standard, potentially counterfeit EPS more attractive to consumers who need to purchase a standalone charger. This underlines the complications that could arise when defining minimum requirements that apply to charger components (in this case, EPS) when sold with a mobile phone, but not when sold separately.

Acceptability

In the public consultation, no questions were asked about interoperability requirements for EPS (option 4). However, the responses suggest that option 5 would be viewed favourably by EU citizens: 80% of respondents would be satisfied with a standardised fast charging solution to ensure optimal performance irrespective of the brand of the mobile phone, and 67% would be satisfied with minimum charging performance rules.

There was no consensus among industry stakeholders about the desirability / acceptability of option 4. Some phone manufacturers expressed support for the idea of making compliance with the relevant standards mandatory in order to guarantee interoperability between different brands of EPS and phones. Others argued that the current approach of voluntary implementation and enforcement by companies should continue, as companies are naturally incentivised to comply with them as much as possible in order to reduce their risk of being isolated from the rest of the market. However, they also argued that the extent of (full or partial) compliance is best left to the discretion of companies, which are best able to balance the requirements of their phones and chargers against the cost impact (for design and testing) of meeting the higher specifications.

Regarding option 5, industry representatives who expressed an opinion were unanimous in their rejection of minimum power requirements for EPS, mainly because they felt it would unfairly penalise low-end products that do not require more than 5 or 10W to charge them in a reasonable time, and because it would unnecessarily curtail manufacturers' ability to determine the "right" trade-off between speed of charging (which increases with higher power) and battery life of the product (which tends to decrease with higher power).
Potential to extend the scope to chargers for other portable electronic devices

In principle, a common EPS for mobile phones that complies with the relevant standards for USB Type-C and (for EPS above 15W) USB PD (option 4), plus potentially delivers at least 15W of power (option 5), could be used across a wide range of other portable electronic devices with similar charging profiles. However, it would not be appropriate for laptops (which require significantly more power, and would therefore only charge very slowly with such an EPS).

As regards smaller devices (such as tablets, e-readers, wearables etc.), similar considerations to those discussed above under the options for the connectors apply. Unless USB Type-C is mandated to be the common connector at the device end for other portable devices (which would give rise to a number of issues and concerns, as outlined above), some of these devices (especially low-value ones) are likely to continue to use USB micro-B connectors (at least until the cost of USB Type-C has dropped significantly), while certain devices with specific requirements (e.g. very small devices) will continue to make use of proprietary (e.g. magnetic) connectors. Although USB Type-C and USB PD technology is backwards compatible - i.e. can be used to charge earlier generations of USB devices – it would be difficult to justify the extra cost of such a high-end EPS for devices that do not use USB Type-C and/or USB PD technology, and would therefore draw no benefit from it in terms of charging performance.

On the other hand, as also outlined previously, it is already relatively common for the kinds of small devices in question (such as action cameras, e-readers, and wearables) to be sold without an EPS. Thus, although a requirement for the EPS – if one is included in the box with the device – to meet certain requirements may appear unnecessarily stringent for certain devices, it might not make much practical difference, as manufacturers could choose to not include one (as many already do). In this way, extending option 4 (or 5) to other portable electronic devices could have an indirect positive effect in terms of increasing decoupling rates for certain devices. However, defining the scope, i.e. exactly which types of devices should be included, would require careful consideration (for the same reasons already outlined under the connector options above).

Consideration of policy instrument

There are no strong reasons per se why a voluntary commitment by mobile phone manufacturers to ensure all their EPS for use with mobile phones comply with the requirements defined under options 4 and 5 would not be possible. As part of the 2009 MoU, signatories undertook to "ensure that each EPS [...] placed by them on the market for use with Mobile Phones is a Common EPS", i.e. complied with the technical specifications and standards (in particular IEC 62684) developed as a result of the MoU. A similar commitment to the latest standards could be envisaged in principle.

However, the feedback received from mobile manufacturers as part of this study (see above) suggests that some of these would be reluctant to commit to option 4, and all would take issue with option 5. This casts doubts on the ability to reach a voluntary agreement. If one were nonetheless considered, the signatories, product scope and timeframe, and mechanisms to ensure compliance already discussed above would need to be considered carefully to ensure its effectiveness.

Possible legal basis

In case of a regulatory initiative to define a common EPS for mobile phones, it appears highly doubtful that a delegated act under the RED could be used. The Directive refers to how radio equipment (incl. mobile phones) is constructed so as to interwork with common chargers, but attempts to use these provisions to regulate the features of the EPS that is used
to charge the phones (rather than the phone itself) would be widely seen as beyond its scope, and therefore run a high risk of legal challenge.

A possible alternative legal basis could be the Low Voltage Directive (LVD) (2014/35/EU), which covers health and safety risks on electrical equipment operating with an input or output voltage of between 50 and 1,000V for alternating current and between 75 and 1,500V for continuous current. It applies to cables and power supply units. Consumer goods with a voltage below 50V for alternating current are covered by the General Product Safety Directive (2001/95/EC). The LVD is a "total harmonised safety Directive" in the sense that it covers all safety aspects of electrical equipment, not just the electrical risks. Nonetheless, since a possible initiative for a common EPS is clearly not primarily aimed at addressing health or safety risks, whether the LVD could provide an appropriate legal basis also seems highly uncertain.

The Ecodesign Directive (2009/125/EC) could also be relevant. Its aim is to improve the environmental performance of products (such as household appliances and ICT equipment) by setting out minimum mandatory requirements for the energy efficiency of these products. Its implementing Regulation (EC) No. 278/2009 sets ecodesign requirements regarding the energy efficiency and no-load consumption of external power supplies (including phone chargers). However, the fact that the common EPS initiative would focus on interoperability (and potentially charging performance), not energy efficiency, means it is difficult to see how such rules could be adopted within the scope of the Ecodesign Directive.

This means that, to the best of our knowledge, there is no existing piece of EU legislation that lends itself neatly to regulating for a common EPS for mobile phones (and potentially other portable electronic devices). Pending a more in-depth legal analysis, which we are not qualified to provide, it therefore appears likely that a new piece of secondary EU legislation, or an amendment to one of the Directives mentioned previously, would have to be considered. Article 114 TFEU enables the EU to adopt measures to harmonise the legislation of the Member States in order to ensure the establishment and functioning of the internal market. Such measures must take into account the need for a high level of protection of the health and safety of people and of the environment.

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65 Voltage ratings refer to the voltage of the electrical input or output, not to voltages that may appear inside the equipment.
66 Annex VII of the LVD Guidelines provides a number of examples of products that are within the scope of the LVD. It includes cables, cord sets and interconnection cord sets (plug + cable + cord set), multiple travel adaptors with supply (e.g. charger for mobile phones or music player), as well as product with integrated plug and/or outlets. 230V for domestic use (e.g. charger for mobile phones, night lights)
6 Comparison of Options

This chapter provides a summary of the various impacts of the options and scenarios, as analysed previously. For some of these impacts (environmental impacts and financial costs), we are able to provide quantitative estimates based on the stock model. The types of impacts for which this is not possible are assessed in qualitative terms. To facilitate comparison, we have used a multi-criteria analysis (MCA) approach, and converted all effects into a common “currency” (from a “major positive” to a “major negative” impact). These are shown in the summary tables below. For the detailed assessments, quantitative estimates, considerations and assumption underlying these, please refer to chapter 5.

Policy options

The summary table overleaf shows the impacts of the five policy options as such, relative to the baseline, without taking into account any potential effects from increased voluntary decoupling that might follow from the options (these are discussed separately below). As can be seen, options 1, 4 and 5 would increase consumer convenience overall. However, this is the only significant positive impact from any of the options. It would need to be weighed against the potential cost implications for mobile manufacturers and/or public authorities, and the risk of negative impacts on innovation. There are also very small negative environmental impacts from all options to harmonise the connectors at the device end, due to the slightly higher weight of the components envisaged.
### Table 31: Summary of the impacts of the policy options

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Connectors at the device end</th>
<th>EPS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Option 1</td>
<td>Option 2</td>
</tr>
<tr>
<td></td>
<td>USB Type-C only</td>
<td>USB Type-C only, for phones with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>proprietary receptacles, adaptors in the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>box compulsory</td>
</tr>
<tr>
<td>Social</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Consumer</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>convenience</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Product safety</td>
<td>-/0</td>
<td>-/0</td>
</tr>
<tr>
<td>Illicit markets</td>
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<td>0</td>
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<tr>
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<tr>
<td>Material use</td>
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<td>CO₂ emissions</td>
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<td>Economic</td>
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</tr>
<tr>
<td>Cost for</td>
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</tr>
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<td>consumers</td>
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<tr>
<td>Adaptation cost</td>
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</tr>
<tr>
<td>for mobile</td>
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<td>0</td>
</tr>
<tr>
<td>manufacturers</td>
<td></td>
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<tr>
<td>Control cost for</td>
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<td>public authorities</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Innovation</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

++ Major positive impact  + Minor positive impact  0 No or negligible impact  - Minor negative impact  -- Major negative impact

NB: All impacts are relative to the baseline scenario. Effects on voluntary decoupling that may result from the options are not included in the scores.

More specifically, the main impacts of, and differences between, the five options can be summarized as follows:

**Option 1:** Only cable assemblies with a USB Type-C connector at the device end are allowed. Cable assemblies that require adaptors are not considered compliant.
Main benefits: As discussed in section 5.2, this would ensure that all consumers can use the cable supplied with their mobile phone to charge any mobile phone irrespective of the brand or model (and potentially also a wide range of other portable electronic devices), and increase the likelihood that users who run out of battery, but have no access to their own charger (e.g. because they are travelling), are able to find a compatible charger. This needs to be seen in the context of the expectation that, in the baseline scenario, around 80% of phones sold in the EU will come with USB Type-C connectors anyway by 2023, which somewhat limits the marginal benefits of this option. There would also be a very small saving to consumer, due to the slightly lower cost of USB Type-C cables compared with Lightning (see section 5.4).

Main costs: This option would entail significant adaptation costs for manufacturers that currently use proprietary connectors in their phones, and could constrain future innovation by effectively ruling out any new “game-changing” proprietary connector technology (though this appears unlikely at present), and by potentially reducing the pace of “incremental” innovation as regards future generations of USB connectors (see section 5.4). There could also be very minor negative environmental impacts due to the slightly higher weight of USB Type-C connectors compared with Lightning (see section 5.3), and a small risk that reducing the number of cables would make it easier for counterfeit products and irresponsible manufacturers to enter the market.

Other considerations: USB Type-C is now a relatively mature technology and as such no raises any technical concerns. However, it appears likely that, by the time new rules come into force (we assume 2023), a new generation of (USB) connectors will begin to appear quite soon, which would limit the practical usefulness (and some of the positive impacts) of this option, and means provisions for an eventual shift to a possible successor technology need to be duly considered when pursuing this option (see section 5.5). As regards its acceptability, a majority of EU citizens would be strongly in favour of this option. The majority of mobile manufacturers consulted for this study also had no objections to this option in principle, but expressed a preference for pursuing it via a voluntary agreement. However, this seems unlikely to be achievable in view of the strong opposition from at least one major manufacturer. If regulatory action is to be taken, a delegated act under the RED could be envisaged, but there remains an element of uncertainty regarding its scope that would necessitate further careful legal analysis.

Option 2: Only cable assemblies with a USB Type-C connector at the device end are allowed. Manufacturers that wish to continue to use proprietary receptacles in their phones are obliged to provide an adaptor from USB Type-C to their proprietary receptacle in the box.

Main benefits: This option would entail minor positive as well as negative impacts for different types of consumers. While the proliferation of cables with USB Type-C connectors would reduce inconvenience for some users (as described above), users of phones with proprietary receptacles would be inconvenienced by the need to use the adaptor each time they charge their main phone. No other benefits are likely.

Main costs: The adaptation costs and constraints on future innovation that would follow from option 1 (see above) are alleviated or eliminated under this option, assuming certain manufacturers choose to continue to use / invest in proprietary solutions in spite of the inconvenience this would cause their customers. Minor negative environmental impacts would follow from the need to ship slightly heavier cables as well as adaptors.

Other considerations: While this option may seem like a viable compromise solution at first, closer scrutiny leads us to conclude it would not generate any net benefits. The public consultation results suggest that consumers
are not keen on adaptors, and the industry is also wary of the idea of obliging companies to include an additional component that not all customers may need, but would still have to pay for. As a result, it seems unlikely this option could be implemented via a voluntary agreement. If regulatory action is to be taken, the uncertainty alluded to above regarding the use of a delegated act under the RED would be even greater under this option, as it is unclear whether the RED could be used as a legal basis to define the essential requirements of accessories (as opposed to the phone itself).

Option 3: Cable assemblies can have either a USB Type-C or a proprietary connector at the device end. Manufacturers that choose to provide a cable with a proprietary connector are obliged to provide an adaptor in the box that enables its use with a USB Type-C receptacle.

- **Main benefits:** This option would generate minor positive impacts for some consumers only. By taking advantage of the adaptor provided, users of phones with proprietary receptacles could use the corresponding cable to also charge other devices (incl. phones) with USB Type-C receptacles. However, the majority of users who own mobile phones with USB Type-C receptacles would reap no benefits from this option.

- **Main costs:** This option eliminates any significant adaptation costs or innovation constraints for manufacturers, but would result in small additional cost for some consumers (the cost of the adaptor), which would also have minor environmental consequences.

- **Other considerations:** It may be possible for industry to commit to this option voluntarily, as many manufacturers view it as a suboptimal but nonetheless acceptable compromise solution. However, it would need to be considered whether this would be worthwhile, given the very limited benefits (and corresponding costs). As with any voluntary initiative pursuant to any of the options, the signatories, product scope and timeframe, and mechanisms to ensure compliance would need to be considered carefully to ensure its effectiveness.

Option 4: Commitment to ensuring all EPS for mobile phones are interoperable. This would be concretised via reference to compliance with the standards IEC 62680-1-3 (for chargers up to 15W) as well as IEC 62680-1-2 and IEC 63002 (for chargers above 15W).

- **Main benefits:** EPS shipped with mobile phones can typically already be used to charge a wide range of other phones / devices. However, there are no guarantees of this, and many consumers’ awareness of the extent to which EPS are interoperable with different phones appears limited. This option would extend and guarantee the interoperability to all modern mobile phones (as well as other devices implementing the USB Type-C and/or USB PD standards), which could be expected to enhance consumer awareness of and confidence in this, and reduce confusion. It would also reduce any residual product safety risks on the EPS side that may result from the growth in fast charging.

- **Main costs:** The interoperability standards that all EPS would have to comply with under this option are very flexible, and don’t pose any major concerns as regards innovation. Nonetheless, this option does effectively rule out any potential innovations in the field of fast charging that are not interoperable with / based on USB PD – but the fact that there is a clear market trend towards charging solutions that are compatible (though not necessarily fully compliant) with USB PD anyway means the effect in practice would be limited. There would also be economic costs (potentially for authorities as well as economic operators) related to the required certification process to ensure compliance. While it was not possible to model the environmental impacts, we
believe any changes would be minimal, as this option would entail a change in protocols and standards, not of hardware or materials.

- **Other considerations**: There are open questions about how compliance with the relevant standards would be monitored and enforced, which would require an additional external certification process and imply additional costs. Also, this option could increase the price of lower-end phones, which would have to include a "better" EPS than they might require. This could have an indirect effect in terms of encouraging higher decoupling rates for lower-end phones, as manufacturers might choose to not include an EPS in order to be able to offer a lower price. While this would be desirable from an environmental perspective, it also raises concerns related to product safety and the illicit market. Industry views on this option are mixed, and a commitment to implementing it voluntarily therefore appears unlikely. At the same time, it appears unlikely that the RED, LVD or Ecodesign Directives would provide a solid legal basis for defining interoperability requirements for the EPS, which means that new secondary legislation might be required.

**Option 5**: To facilitate adequate charging performance, all EPS for mobile phones would have to guarantee the provision of at least 15W of power (in line with most current fast charging technologies). To also ensure full interoperability, all EPS would have to be capable of "flexible power delivery" in accordance with common (USB PD) standards / specifications.

- **Main benefits**: This option would deliver the same consumer benefits as option 4 (see above). In addition, it would ensure consumers are able to charge their phones with another charger at a similarly fast speed, and thereby largely eliminate a source of inconvenience experienced by the majority of consumers (according to our panel survey).

- **Main costs**: This option would result in similar innovation constraints and control costs as option 4 (see above). It may also generate adaption costs for manufacturers of low-end mobile phones, which would need to move towards USB PD a bit faster than the current pace. In addition, since all EPS would have to provide over 15W, the cost for consumers is expected to be very slightly higher than in the baseline (though this could not be modelled quantitatively).

- **Other considerations**: The questions about the certification process and its costs raised above also apply to option 5, while the concerns about the potential price impact would be exacerbated by adding minimum power requirements. As a result, industry representatives who expressed an opinion were unanimous in their rejection of this option, not only because they felt it would unfairly penalise low-end products that do not require more than 5 or 10W to charge them in a reasonable time, but also because it would curtail manufacturers' ability to determine the "right" trade-off between speed of charging (which increases with higher power) and battery life of the product (which tends to decrease with higher power). A voluntary agreement therefore seems very unlikely. As regards regulatory action, the same considerations relating to the possible legal basis as under option 4 apply.

In summary, options 1, 4 and 5 would generate benefits in terms of consumer convenience. These vary by option, subgroup of consumers, and situation (the different options would mitigate the different main sources of inconvenience experienced by consumers in the current situation to varying degrees). These benefits need to be seen in the context of the dynamic baseline scenario, which envisages certain key trends (in particular the complete substitution of USB micro-B by USB Type-C connectors at the device end, and market convergence towards fast charging technologies that are compatible with USB PD) that are likely to decrease consumer inconvenience anyway. This means that the additional
benefits from all options when they come into force (assumed to be 2023) will be smaller than they would be in the current situation (2019).

All options are likely to have economic costs, some of which may be non-negligible, and would therefore need to be weighed up against the consumer benefits. In addition, there are certain risks and issues related to the technical feasibility, acceptability, and most appropriate policy instrument that would need to be carefully considered.

We also conclude that the options as formulated are likely to have a very small negative environmental impact, as they would lead to subtle changes in the types of charger components and/or accessories, but not have a direct effect on the number of chargers produced and discarded. A reduction in the number of chargers (and hence their environmental impact) would only be achieved via decoupling, which was assessed separately.

Decoupling

In theory at least, the EU could legislate to make decoupling compulsory (i.e. require mobile phones to be sold without an EPS, or even with neither a cable nor an EPS). However, this study has not considered mandatory decoupling as an option, because it would have exceeded the scope of the initiative as framed by the European Commission (namely to focus on a "common charger"), and would have required a different set of approaches to the data collection and analysis to assess its likely impacts, risks, etc.

However, we have considered the extent to which the initiative as currently framed could help to facilitate voluntary decoupling, i.e. lead economic operators to offer phones without chargers (without being required to do so), and their customers to make use of this option. To do so, we have defined three decoupling scenarios (lower, mid and higher case), to estimate the effects on voluntary decoupling that appear feasible (for details see section 5.1).

We have also considered the extent to which the preconditions for increased decoupling are likely to be affected by each of the specific policy options, and hence which of the scenarios appears most relevant. This led us to conclude that the options that are focused on the device-end connectors (options 1, 2 and 3) in isolation (i.e. without any other accompanying measures) would be very unlikely to lead to anything more than the lower case scenario. The EPS options (options 4 and 5) have the potential to facilitate more significant decoupling, up to the mid case scenario. The highest possible rates only appear plausible as a result of the combination of the maximum harmonisation options for both the device-end connectors and the EPS.

However, it is important to re-emphasise that this would depend on a range of factors, including possible accompanying information campaigns or other measures taken by the Commission and/or other public authorities, and the specific commercial and other decisions made by economic operators. Therefore, the considerations summarised here (and explained in further detail in section 5.1) should be interpreted not as firm predictions, but only as illustrations of the potential effects of the options. The very high degree of uncertainty should always be kept in mind.

With this in mind, Table 32 summarises the impacts we expect to be achieved by each of the decoupling scenarios. In summary, the higher the decoupling rates, the greater the environmental benefits (for quantified estimates see section 5.3) and the cost savings for consumers (see section 5.4), as well as the convenience benefits for the large number of consumers who feel they have too many chargers taking up space in their home and/or workplace. However, more
decoupling would also be likely to lead to growth in the market for standalone chargers and, by extension, in the sales of unsafe and/or counterfeit chargers.

Table 32: Summary of the impacts of the decoupling scenarios

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Decoupling scenarios</th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Mid</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(max. 5% for EPS,</td>
<td>(max. 15% for EPS,</td>
<td>(max. 40% for EPS,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.5% for cables)</td>
<td>7.5% for cables)</td>
<td>20% for cables)</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer convenience</td>
<td>0/+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Product safety</td>
<td>0/-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illicit markets</td>
<td>0/-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material use</td>
<td>+</td>
<td>+/+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>E-waste</td>
<td>+</td>
<td>+/+</td>
<td></td>
<td>++</td>
</tr>
<tr>
<td>CO₂ emissions</td>
<td>+</td>
<td>+/+</td>
<td></td>
<td>++</td>
</tr>
<tr>
<td>Economic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost for consumers</td>
<td>0/+</td>
<td>+</td>
<td>-/+</td>
<td></td>
</tr>
<tr>
<td>Adaptation cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>for mobile manufacturers</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Control cost for</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>public authorities</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Innovation</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

++ Major positive impact  + Minor positive impact  0 No or negligible impact  - Minor negative impact  -- Major negative impact

NB: All impacts are relative to the baseline scenario, which assumes no decoupling.

Other portable electronic devices

Finally, the study was also tasked with analysing the possible indirect impact on the EU market for other small portable electronic devices requiring similar charging capacity. In this context, it has considered two key questions:
Would a common charger for mobile phones have indirect effects on the markets for other portable devices?

The fact that such a high proportion of consumers own a mobile phone means that phones have an influence on the market for other devices. For example, it is already relatively common for some small devices (such as action cameras, e-readers, and wearables) to be sold without a complete charging solution (usually with a cable, but without an EPS); this is based partly on the expectation that customers will be able to use their mobile phone chargers. The adoption of a common connector and/or EPS across all mobile phones could therefore be expected to also contribute to a greater and/or faster adoption of this in other electronic devices in which this makes technological, practical and commercial sense (which would likely be the case for many but not all small devices; see below). It could thus reinforce the existing trend of a gradual increase in the take-up of USB Type-C and USB PD technology and standards in other markets. In turn, this could also have the indirect effect of increasing decoupling rates for certain devices.

Could / should the scope of a possible initiative be extended to include devices other than mobile phones?

From a technical perspective, both USB Type-C connectors (option 1) and compliant EPS (options 4 and 5) could be used for a wide range of devices, including tablets, e-readers, wearables, and even laptops (although the latter require significantly more power, and would therefore only charge very slowly with the kind of EPS envisaged here). However, making the use of such chargers (connectors and/or EPS) mandatory for devices beyond mobile phones would give rise to a number of issues and concerns, the most significant of which are: cost implications (requiring devices, especially low value ones, to ship with a charger that is more sophisticated and/or powerful than required would increase their cost for consumers); devices with specific requirements (e.g. very small devices, or those that operate in extreme environments, and for which USB Type-C connectors would not be appropriate); and, loosely related to this, the product scope (in the absence of a usable definition of what constitutes a "small portable electronic device", the types of devices covered would need to be considered very carefully). Specifically regarding options 4 and 5, these concerns could be partly mitigated by the following consideration: as outlined above, certain kinds of small devices are already routinely sold without an EPS. Thus, although a requirement for the EPS to meet certain requirements may appear unnecessarily stringent (and expensive) for certain devices, this could lead more manufacturers to choose to not include one. In this way, extending option 4 (or 5) to other portable electronic devices could have a positive effect on voluntary decoupling rates for such devices, and lead to fewer EPS being produced and discarded.
Annexes

Annex A: Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternating Current (AC)</td>
<td>AC is an electric current which periodically reverses direction, in contrast to direct current (DC) which flows only in one direction. Alternating current is the form in which electric power is delivered to businesses and residences, and it is the form of electrical energy that consumers typically use when they plug appliances into a wall socket.</td>
</tr>
<tr>
<td>Consumer panel</td>
<td>Group of individuals selected by a business or organization to provide input and opinion on products and services for research on consumer behaviour. Panel members are chosen to be representative of the general population or a target group.</td>
</tr>
<tr>
<td>Counterfeit charger</td>
<td>Counterfeit chargers (external power supplies and/or connector cables) are chargers infringing intellectual property right(s), such as trademark, patent and design. They have a reputation for being lower quality (e.g., they can damage batteries). They frequently do not fulfill safety requirements, thus posing risks to consumer safety (e.g., risk of causing electrocution, starting a fire).</td>
</tr>
<tr>
<td>Decoupling</td>
<td>Sale of mobile phones without including a charger.</td>
</tr>
<tr>
<td>External Power Supply (EPS)</td>
<td>Device which meets all of the following criteria, as per Regulation 278/2009 on ecodesign: (a) it is designed to convert alternating current (AC) power input from the mains power source input into lower voltage direct current (DC) or AC output; (b) it is able to convert to only one DC or AC output voltage at a time; (c) it is intended to be used with a separate device that constitutes the primary load; (d) it is contained in a physical enclosure separate from the device that constitutes the primary load; (e) it is connected to the device that constitutes the primary load via a removable or hard-wired male/female electrical connection, cable, cord or other wiring; (f) it has nameplate output power not exceeding 250 Watts; (g) it is intended for use with electrical and electronic household and office equipment as referred to in Article 2(1) of Regulation (EC) No 1275/2008.</td>
</tr>
<tr>
<td>High-end phones</td>
<td>Phones that are amongst the most expensive or advanced in a company’s product range, or in the market as a whole.</td>
</tr>
<tr>
<td>In-the-box charger</td>
<td>Chargers that are sold together with the mobile phone, when consumers buy a new phone.</td>
</tr>
<tr>
<td>Lightning</td>
<td>Proprietary computer bus and power connector created by Apple Inc. It was introduced on September 2012 to replace its predecessor, the 30-pin dock connector. The Lightning connector is used to connect Apple mobile devices like iPhones, iPads, and iPods to host computers, external monitors, cameras, external power supplies, and other peripherals. Using 8 pins instead of 30, Lightning is significantly more compact than the 30-pin dock connector and can be inserted with either side facing up. However, unless used with an adapter, it is incompatible with cables and peripherals designed for its predecessor.</td>
</tr>
<tr>
<td>Low-end phones</td>
<td>Phones that are amongst the cheapest in a company’s product range, or in the market as a whole.</td>
</tr>
<tr>
<td>Low Voltage Directive (LVD)</td>
<td>Directive of the European Parliament and of the Council on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment. The LVD focuses on health and safety risks, and applies to a wide range of equipment designed for use within certain voltage limits, including power supply units.</td>
</tr>
<tr>
<td>Memorandum</td>
<td>Nonbinding agreement between two or more parties outlining the terms and details of an agreement.</td>
</tr>
<tr>
<td><strong>Understanding (MoU)</strong></td>
<td>Understanding, including each parties' requirements and responsibilities. It expresses a convergence of will between the parties, indicating an intended common line of action.</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Mobile phone</strong></td>
<td>Battery-powered handheld communication device of which the primary purpose is voice telephony, which operates on public cellular networks, which potentially supports other services and which is designed to be hand-portable.</td>
</tr>
<tr>
<td><strong>Radio Equipment Directive</strong></td>
<td>The Radio Equipment Directive 2014/53/EU (RED) establishes a regulatory framework for placing radio equipment on the market. It ensures a Single Market for radio equipment by setting essential requirements for safety and health, electromagnetic compatibility, and the efficient use of the radio spectrum. It also provides the basis for further regulation governing some additional aspects. These include technical features for the protection of privacy, personal data and against fraud. Furthermore, additional aspects cover interoperability, access to emergency services, and compliance regarding the combination of radio equipment and software.</td>
</tr>
<tr>
<td><strong>PMA</strong></td>
<td>Power Matters Alliance (PMA) was a global, not-for-profit, industry organization whose mission was to advance a suite of standards and protocols for wireless power transfer. The organization was merged with Alliance for Wireless Power (A4WP) in 2015 to form AirFuel Alliance.</td>
</tr>
<tr>
<td><strong>Preferred Charging Rate</strong></td>
<td>Concept introduced in the MoU signed in 2008. It was defined as charging a battery from 10% capacity to 90% capacity within a maximum of 6 hours.</td>
</tr>
<tr>
<td><strong>Proprietary charging solution</strong></td>
<td>Charging solution owned 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.</td>
</tr>
<tr>
<td><strong>Qi</strong></td>
<td>Open interface standard that defines wireless power transfer using inductive charging over distances of up to 4 cm, and is developed by the Wireless Power Consortium. The system uses a charging pad and a compatible device, which is placed on top of the pad, charging via resonant inductive coupling. The Wireless Power Consortium (WPC) is a multinational technology consortium formed in December 2008. Its mission is to create and promote wide market adoption of its interface standard Qi. It is an open membership of Asian, European, and American companies, working toward the global standardization of wireless charging technology.</td>
</tr>
<tr>
<td><strong>Quick Charge</strong></td>
<td>Quick Charge is a Qualcomm's proprietary technology which allows for the charging of battery powered devices, primarily mobile phones, at levels above and beyond the typical 5 volts and 2 amps for which most USB standards allow. To take advantage of Qualcomm Quick Charge, both the external power supply and the device must support it.</td>
</tr>
<tr>
<td><strong>Standalone charger</strong></td>
<td>External power supplies sold on their own, without being part of a full package including a phone (or another device) and the charger.</td>
</tr>
<tr>
<td><strong>Universal Serial Bus (USB)</strong></td>
<td>USB is an industry standard that establishes specifications for cables, connectors and protocols for connection, communication and power supply between personal computers and their peripheral devices, or between a device and the external power supply. Released in 1996, the USB standard is currently maintained by the USB Implementers Forum (USB IF).</td>
</tr>
<tr>
<td><strong>USB-IF</strong></td>
<td>The non-profit USB Implementers Forum, Inc. was formed to provide a support organization and forum for the advancement and adoption of USB technology as defined in the USB specifications. The USB-IF facilitates the development of high-quality compatible USB devices through its logo and compliance program, and promotes the benefits of USB and the quality of products that have passed compliance testing.</td>
</tr>
<tr>
<td><strong>USB micro-B</strong></td>
<td>Connector (B-Plug and B-Receptacle) which can be used for charging support and additional functions, whose reference specification is &quot;Universal Serial Bus Cables and Connector Class Document&quot; Revision 2.0 August 2007, by the USB Implementers Forum.</td>
</tr>
<tr>
<td><strong>USB Type C</strong></td>
<td>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 while mandating only a few of them.</td>
</tr>
<tr>
<td><strong>USB 3.1</strong></td>
<td>USB 3.1, released in July 2013, is the successor standard that replaces the USB 3.0 standard. USB 3.1 preserves the existing SuperSpeed transfer rate, giving it the new label USB 3.1 Gen 1, while defining a new SuperSpeed+ transfer mode, called USB 3.1 Gen 2 which can transfer data at up to 10 Gbit/s over the existing USB-type-A and USB-C connectors (1250 MB/s, twice the rate of USB 3.0).</td>
</tr>
<tr>
<td><strong>USB 3.2</strong></td>
<td>USB 3.2, released in September 2017, replaces the USB 3.1 standard. It preserves existing USB 3.1 SuperSpeed and SuperSpeed+ data modes and introduces two new SuperSpeed+ transfer modes over the USB-C connector using two-lane operation, with data rates of 10 and 20 Gbit/s (1250 and 2500 MB/s).</td>
</tr>
<tr>
<td><strong>USB Power Delivery</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>USB Fast Chargers</strong></td>
<td>Certified USB Fast Chargers support the Programmable Power Supply (PPS) feature of the USB Power Delivery 3.0 specification. New USB hosts, devices and chargers supporting PPS are required for users to take full advantage of this feature. Certified USB Fast Chargers are backwards compatible with devices that support USB Type-C™ and USB Power Delivery.</td>
</tr>
<tr>
<td><strong>Wireless charging</strong></td>
<td>Inductive charging (also known as wireless charging or cordless charging) is a wireless charging that uses an electromagnetic field to transfer energy between two objects through electromagnetic induction. This is usually done with a charging station. Energy is sent through an inductive coupling to an electrical device, which can then use that energy to charge batteries or run the device.</td>
</tr>
<tr>
<td><strong>30-pin connector</strong></td>
<td>Apple’s proprietary connector, common to most Apple mobile devices (iPhone (1st generation), iPhone 3G, iPhone 3GS, iPhone 4, iPhone 4S, 1st through 4th generation iPod Touch, iPad, iPad 2, and iPad 3) from its introduction with the 3rd generation iPod classic in 2003 until the Lightning connector was released in late 2012.</td>
</tr>
</tbody>
</table>
Annex B: Public consultation synopsis report

The online Public Consultation on standard chargers for mobile phones was launched on 14 May 2019 and closed on 6 August 2019. In total, 2,850 responses were received.

The Public Consultation was part of a broader evaluation of potential policy interventions aimed at assessing the opportunity to mandate a common charger for mobile phones across the European Union. This survey sought to gather opinions and evidence on the current situation for chargers for mobile phones and other battery-powered devices.

A variety of private and public stakeholders were invited to take part in the Public Consultation. The vast majority of responses (2,743 entries) came from EU citizens.

The Public Consultation showed generalised support among respondents for the standardisation of mobile phones chargers, and possibly extending standardisation to other battery-powered devices. Approval for standardisation was normally higher among citizens compared to industry stakeholders, although common concerns to both groups were innovation and electronic waste. Consumers also highlighted that financial costs and performance issues arose as a consequence of the variety of chargers in circulation. Both consumers and manufacturers were in favour of harmonisation, although citizens more consistently supported regulatory intervention. The views of NGOs, consumer associations, research institutions, and public authorities tended to be in line with those of individual citizens.

Methodology

The online consultation was open to everyone who wished to contribute on the topic of standard chargers for mobile phones. It aimed to reach as many respondents as possible and for this reason it had a stated target audience of a wide array of stakeholders, including, but not limited to, consumers and consumer associations, economic operators potentially affected by regulatory action, Member States’ authorities, Market Surveillance Authorities for the Low Voltage Directive 2014/35/EU and Radio Equipment Directive 2014/53/EU, and the European Standardisation organisations. As part of a set of preliminary questions, respondents were asked to indicate the capacity in which they were answering.

The Public Consultation comprised 10 sections of mandatory questions, and additional questions that were based on previous responses. Optional open-ended questions allowed respondents to further elaborate on each section.

The survey was mainly promoted through social media channels. In light of the way it was made available and circulated, caution should be exercised when interpreting its results due to the likely presence of selection bias. In other words, the respondents that took part in this survey do not form a representative sample but are likely to be those with a strong interest in the topic (and/or a particular policy response).

Overview of the respondents

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%).

34 companies, business organisations, and business associations\(^6\) 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

\(^6\) 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.
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 (including mobile phone manufacturers and other technology firms), whilst 13% were telecommunications companies, two testing bodies, and one represented a certification body. The remainder came from a variety of other sectors, including human relations, training providers, and the retail sector.

19 individuals representing public authorities submitted their views. Of these, five stated that their authorities had an international scope, 12 a national dimension, and the rest a regional competence.

Fewer responses were received from NGOs, consumer organisations, and academic institutions – overall reaching 14 contributions. The three participating 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.

**Knowledge of the current situation**

**Mobile phones**

Respondents were asked to describe the situation regarding the number of mobile phone chargers available on the market. 68% of all respondents believed that there were a few different types of chargers on the market; 32% indicated that there are many different types of chargers. Less than 1% considered that only one type of charger existed.

Just over half of the respondents (51%) considered that external power supplies (EPSs) could be used with most phones, providing that they were used with the right cable, while 30% mentioned that both cable and EPS can be used with most phones. 14% indicated that it is normally difficult to interchangeably use chargers, while 4% deemed it possible to use the cable, but not the EPS, to charge other mobile phones.

63% of EU citizens declared that they feel ‘dissatisfied’ (41%) or ‘very dissatisfied’ (22%) with the present situation, with only 17% stating that they are ‘satisfied’ or 4% ‘very satisfied’. A neutral opinion was expressed by 16% of respondents. Figures from businesses and business associations are markedly different, with 62% of satisfaction and 32% of dissatisfaction, and only 3% of neutral opinions.
In open-ended answers, whilst consumers tended to highlight a variety of drawbacks related to the absence of a common standard solutions, ranging from environmental issues to financial aspects, businesses and business organisations underlined the progress made following the two Memoranda of Understanding (MoU), as well as the recent consensus achieved over the promotion of USB Type C as the new charging standard. The views of public authorities were varied, with certain respondents stressing the inconvenience caused by the existence of multiple types of connectors, while others underlined how progress had been made thanks to industry-wide agreements. However, certain public authorities’ representatives suggested that there could be room for improvement of standardisation, as having multiple chargers is also a problem in terms of e-waste.

Other devices

When asked about the situation related to the number of chargers for other devices, 56% of all respondents indicated that there are many different types of chargers, whilst 36% noted that there are a few types in circulation. 1% considered that there was only one type of charger, whilst 6% were unable to provide an answer.

38% of respondents deemed it impossible to use chargers to charge different electronic devices, whilst 33% indicated that it is possible to make use of the EPS, but not of the cable, to charge other devices. The possibility of using the whole charger with other devices was indicated by 18% of respondents, while 4% indicated that the cable, but not the EPS, could be used with other devices. Nearly 8% had no opinion or did not know the answer.

The percentage of respondents dissatisfied with this situation was 34%, whilst 29% declared to be very dissatisfied. 11% of respondents were satisfied, and 3% very satisfied. 16% held neutral views.
Figure 32: Are you satisfied with the current situation regarding mobile phone chargers for portable electronic devices other than mobile phones and their seamless interconnection?

Some consumers highlighted that different charging solutions might be needed for different devices as a result of diverging technical requirements. NGOs considered that the variety of chargers present on the market is a source of difficulties for the visually impaired and the disabled. Public authorities stressed that certain devices were increasingly sold without chargers, and that improvements were taking place as there was a pattern of convergence towards USB Type C. However, some stakeholders from public authorities suggested that having different types of chargers for different phones was a source of inconvenience especially when travelling.

**Problems experienced**

The Public Consultation sought to establish which problems – if any – respondents experienced as a result of the situation relating to chargers. At times, divergent views were expressed by consumers, consumer associations, public authorities, and NGOs on one side, and business stakeholders on the other.
Figure 33: Do you agree that the current situation regarding chargers for mobile phones results in:

<table>
<thead>
<tr>
<th>Area</th>
<th>Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Don't Know/No Opinion</th>
<th>Neither Agree or Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative environmental impacts</td>
<td>50%</td>
<td>23%</td>
<td>9%</td>
<td>4%</td>
<td>6%</td>
<td>11%</td>
</tr>
<tr>
<td>Inconvenience for mobile phone users</td>
<td>34%</td>
<td>42%</td>
<td>10%</td>
<td>5%</td>
<td>4%</td>
<td>11%</td>
</tr>
<tr>
<td>Financial costs for mobile phone users</td>
<td>54%</td>
<td>36%</td>
<td>10%</td>
<td>6%</td>
<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td>Performance issues (regarding the time it takes to charge phones)</td>
<td>28%</td>
<td>34%</td>
<td>11%</td>
<td>4%</td>
<td>6%</td>
<td>11%</td>
</tr>
<tr>
<td>Safety concerns or risks</td>
<td>13%</td>
<td>19%</td>
<td>19%</td>
<td>14%</td>
<td>11%</td>
<td>75%</td>
</tr>
<tr>
<td>The ability for consumers to choose from a wide range of charging options</td>
<td>11%</td>
<td>28%</td>
<td>27%</td>
<td>16%</td>
<td>5%</td>
<td>21%</td>
</tr>
<tr>
<td>A sufficient degree of seamless interconnection of chargers</td>
<td>7%</td>
<td>23%</td>
<td>35%</td>
<td>17%</td>
<td>2%</td>
<td>14%</td>
</tr>
</tbody>
</table>

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.

Half of EU citizens strongly agreed that a clear environmental impact arose from the situation and 23% agreed with this. 11% was of a neutral opinion, and only 9% considered that there was no environmental impact (5% disagreed and 4% strongly disagreed).

EU citizens indicated that having multiple types of chargers caused performance issues (28% strongly agreed and 34% agreed). 16% expressed neutral views, 11% disagreed and 5% strongly disagreed.

Most EU citizens indicated that the situation resulted in a financial burden for mobile phone users: 36% agreed and 34% strongly agreed with this statement. 13% did not have a clear opinion on the matter, whilst 10% disagreed and 6% strongly disagreed with the fact that the situation resulted in financial costs.

Safety hazards were linked to the presence of multiple types of chargers for 32% of EU citizens (13% strongly agreed, 19% agreed). Similar percentages disagreed and strongly disagreed (19% and 14% respectively), although 1 in 4 EU citizens had a neutral opinion on the topic.

Only 33% of EU citizens saw the situation as beneficial in terms of variety of choice (11% strongly agreed, 22% agreed). 41% did not consider the situation to be beneficial (21% disagreed and 27% strongly disagreed). However, 22% held neutral views.

25% of EU citizens strongly agreed with the statement that chargers presented a seamless degree of interconnection, while 7% strongly agreed. However, 14% held a neutral opinion, and the majority disagreed (with 34% disagreeing and 17% strongly disagreeing).

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

The views of those who responded that the present situation generates inconvenience (N=2,161, or 76% of all respondents) were further analysed with an additional set of questions.

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

- 73% of EU citizens believed the fact that users of different electronic devices (including but not limited to mobile phones) 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 respondents 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.

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.

Environment

Environmental concerns (N=2054, or 72%) were further analysed.

• Those EU citizens concerned by the environmental impact of multiple types of chargers indicated as a serious problem the fact 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.

Performance

The views of those respondents who had highlighted that a situation in which multiple types of chargers are present causes performance issues (N=1773, or 62%) were further analysed.

• 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.

• The fact that, as a result of this situation, mobile phones take too long to charge was indicated as a serious problem by half of the EU citizens who had indicated safety as a problem, while 46% considered it a minor problem. 4% did not feel that this was 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 for performance.
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 which consumers have to bear, while noting that financial costs are generally a minor problem as chargers are usually affordable.

Safety

Narrowing the sample to those who judged that the situation posed a safety hazard (N=899, or 32%), a clear majority of EU citizens indicated that unbranded chargers or chargers not specifically designed for the mobile phone in use may be potentially unsafe. The results showed that:

• Safety concerns were also caused by the presence of many counterfeit chargers on the market. Most EU citizens (80%) among those who had indicated safety-related problems suggested that this was a serious problem, and 16% that it was a minor issue. 2% did not report the presence of counterfeit chargers as a problem.

• Safety was a serious concern for 72% of EU citizens, while it was a minor problem for 21% of them. Only 5% did not consider this an issue.

However, business stakeholders appeared more likely to indicate the presence of counterfeit chargers as a serious problem compared to EU citizens (90% vs 80% respectively).

In their open-ended comments, European citizens appear particularly concerned about the impact of counterfeit or unsafe chargers on devices (e.g. in terms of battery life). Similar views were expressed by public authorities, concerned with limitations to interoperability.

The competitiveness of the market for chargers is stressed by the business sector; yet, business stakeholders also underlined that sub-standard chargers are potentially unsafe for users. Following these considerations, business stakeholders questioned whether a single charger type would increase hazards by indirectly favouring the commercialisation of counterfeit or sub-standard charging solutions.

Expected situation in the next 5-10 years

EU citizens are divided on the future of mobile phone chargers, should the EU refrain from acting. 32% believed that the situation would remain broadly unchanged, whilst 34% expected the number of chargers on the market to increase due to the introduction of new charging solutions. However, 19% foresaw a natural convergence of the types of chargers.
available that would lead to a reduction in the number of chargers available. 13% indicated wireless charging as the standard which would entirely replace other charging standards.

Consumer associations and NGOs held stronger views relative to the fact that the number of types of chargers is set to increase (63%), while 25% expected a downward trend. 13% indicated that the situation would remain the same. Public authorities were strongly (58%) of the opinion that the number of different types of chargers would increase without any standardisation measure.

Differences are marked when considering businesses' and business organisations' opinions. An equal share of stakeholders (26%) considered that the number of chargers could either increase or decrease. 24%, instead, predicted that the situation would be broadly unchanged, while for 15% wireless charging would replace cable charging entirely.

Figure 34: Do you think the situation would change in the next 5-10 years if the EU takes no action?

There seems to be strong consensus among EU citizens on the need for a common charger model. A 63% majority was in favour of the European Union exercising its regulatory power to mandate a charger standard, whilst 31% considered that the EU should promote an industry-wide agreement. Only 6% of EU citizens suggested that the EU should abstain from any form of intervention. Support for a common charging solution 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.
All NGOs, public authorities, and consumer associations are in favour of further action. A large majority (75%) leaned towards regulatory intervention, while 1 in 4 recommended an industry-led agreement.

Figure 35: Should the EU take further action to create a standard charger for mobile phones?

- No, further action is not needed
- Yes, the EU should impose a standard charger by law (regulatory action)
- Yes, the EU should insist that the industry commits to a standard charging solution (voluntary action)
- No opinion/Don’t know

Source: Public Consultation (2019). N=2850

Preferences for a standard charging solution

The view of those respondents who expressed support for an EU intervention to standardise chargers (N=2,653, or 93%) were further investigated.
Figure 36: If you responded that the EU should take further action to create a standard charger for mobile phones, would you be satisfied with the following solutions for standard mobile phone chargers?

<table>
<thead>
<tr>
<th>Solution</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardise fast charging solutions to ensure optimal performance when used with different brands of mobile phones</td>
<td>80%</td>
<td>14%</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standardise wireless charging solutions for use with different brands of mobile phones</td>
<td>79%</td>
<td>13%</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The standard charger is the combination of a single standard connector placed on the side of the mobile phone (suitable for all mobile phones on the market) and a single connector type placed on the external power supply (with a detachable cable)</td>
<td>77%</td>
<td>12%</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The standard charger results in a single standard connector placed on the side of the mobile phone and is suitable for all mobile phones on the market (either detachable or non-detachable cable)</td>
<td>76%</td>
<td>13%</td>
<td>9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set minimum charging performance rules (e.g. charging 80% of battery in a certain amount of time) independently of the charger brand</td>
<td>67%</td>
<td>22%</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The standard charger is on the external power supply side and results in a single connector type placed between the power supply and the detachable charging cable</td>
<td>51%</td>
<td>22%</td>
<td>21%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Create adaptors to enable the use of different charger types with different mobile phones</td>
<td>25%</td>
<td>16%</td>
<td>56%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

• The standardisation of fast-charging solutions found broad consensus among EU citizens (80% would be satisfied with this solution). Neutral views were expressed by 14% of EU citizens, while 6% would be dissatisfied by this measure.

• Similar percentages were recorded for the standardisation of wireless charging solutions (79% satisfied, 13% neutral, and 3% dissatisfied).

• The standardisation of the whole charger would be the preferred option for 77% of EU citizens, whilst 12% have no clear view and 7% would be against it. Similar views are expressed in the case of the imposition of a standard only for the cable on the device side.

• Setting minimum charging performance rules would be the preferred option of 67% of EU citizens in favour of further action, 22% indicated a neutral opinion, and only 6% would be dissatisfied.

• More mixed views are expressed by consumers when considering standardisation only on the EPS side. 52% of EU citizens would endorse this solution, although 21% would be dissatisfied. A neutral opinion was held by 22% of citizens. Standardising only the connector on the phone side saw 76% of EU citizens satisfied, 13% with neutral opinions, and 8% dissatisfied.

• EU citizens in favour of further action would generally be dissatisfied with the creation of adaptors to ensure interoperability among chargers. Only 25% would be satisfied with the introduction of adaptors, whilst 56% would consider this option dissatisfying. 16% recorded a neutral opinion.

There is broad support among business stakeholders for the standardisation of wireless chargers (77%) and fast-charging chargers (73%); consensus for alternative forms of standardisation is slightly lower. Within the business sector, only 22% agree that adaptors could be an option.

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%). Harmonisation for chargers of other devices, such as GPS navigation systems and battery-powered household appliances, is desirable for 65% and 60 of EU citizens respectively. Battery toys chargers should be harmonised for 51% of EU citizens. An even stronger endorsement for standardisation came from NGOs and consumer associations. Public authorities hold stronger views compared to consumers on the need for standardisation of other devices apart from toys and household appliances.

The business sector was generally more cautious about the standardisation of other devices. Only tablets seem to aggregate broad consensus (68%), with all other items being below 50% of support (household appliances at 32%, being the item which received the lowest share of agreement).

A pattern seems to emerge from some consumer opinions that different standards could be set for different device types, in consideration of their different power requirements. As some consumers appear to suggest, a certain degree of flexibility should be allowed to encourage innovation. Consumers also indicated headphones, gaming consoles, and electric vehicles as other potential areas for standardisation.
Business stakeholders highlighted that one option could be to devise EPSs that could adapt to the power requirements of the device they are charging or to create clearly identifiable categories of chargers. Public authorities, in open-ended comments, suggested that a rule for standardisation could be to impose bands based on product requirements – i.e. standardising chargers for devices with similar technical requirements.

### Foreseeable impacts of EU action

According to EU citizens, there would be many gains from the introduction of a standardisation solution.

- Most citizens mentioned convenience for consumers; 83% believed the impact would likely be positive, 8% possibly positive, and only 2% likely negative or possibly negative.

- The second most likely positive impact would be on the reduction of e-waste (73% considered it likely positive, 15% possibly positive, 2% possibly negative, and 4% likely negative).

- Another likely positive impact would be on financial costs (likely to decrease for 70% of EU citizens, possibly decreasing for 18%, possibly not decreasing for 3%, and not decreasing for 4%).

- Enhanced conservation of natural resources would be a likely positive outcome for 67% of EU citizens, possible for 18%, possibly negative 2%, and likely negative for 3%.

- Consumer choice would be likely be impacted positively for 66% of EU citizens, possibly positively for 19%, possibly negatively for 4%, and likely negatively for 5%.

- 64% believed that standardisation was likely to result in improved safety (64% likely, 18% possible, whilst 2% and 1% respectively judged the impact possibly negative or likely negative).

- Reduced CO2 emissions were likely to be impacted upon positively for 63% of EU citizens, possibly positively for 17%, possibly negatively impact for 2%, and a likely negatively impact for 3%.

- A positive impact was believed to be less likely on the competitiveness of EU industry (40% judged it likely, and was possible for 28% of EU citizens, while it was indicated as possible negative by 6% and likely negative by 7% of EU citizens.

- Expected impact on profitability of mobile phone manufacturers were likely positive for 31% of EU citizens, possibly positive for 30%, possibly negative for 10%, and likely negative for 11%.

- Impacts on curbing counterfeiting were likely positive for 30%, possible positive for 14%, possible negative for 12%, and likely negative for 18% of EU citizens.

- The impact on profitability of charger producers was deemed likely positive for 27%, possible for 26%, possible negative for 12%, and likely negative for 20%.

However, when considering impacts on the industry, uncertainty in responses among EU citizens is generally high (between 13% and 25% depending on the type of impact).
Businesses and business organisations were generally more cautious in judging potential impacts as positive. Particularly business stakeholders highlighted negative impacts in terms of safety (32% suggesting that the effects would be likely negative), or in terms of counterfeit chargers in circulation (29% indicating effects as likely negative). Alongside indicating likely negative effects on profitability for charger manufacturers and phone producers (18% and 29% respectively), 41% of businesses and business organisations also expected likely negative impacts on innovation.

In open-ended comments, the industry highlighted the potential consequences of standardisation in terms of international trade hindrance, and the resulting disadvantage that could affect European consumers. They expressed concern for reduced choice for EU citizens, whilst also warning against the risk that, with a mandated solution, chargers should be larger in size in order to ensure interoperability. Industry stakeholders also highlighted the potential negative impact on SMEs.

**Information on identified campaigns**

Five contributions among those submitted by business associations appear to be similar and based on a common script. The main themes that were highlighted in the case of the proposed standardisation of mobile phone chargers were:

- The fact that in 2013, by virtue of the MoU, standardisation had been achieved for over 90% of all handsets sold in the EU;
- The industry is naturally switching to USB Type C as a standard;
- A natural transition avoids unnecessary e-waste and is convenient for consumers;
- The transition will be completed by February 2019;
- Micro-USB remains a viable solution for low-end devices.

Relative to other devices, the main considerations submitted were:

- There is a new MoU in place as of March 2018 for convergence towards USB Type C;
- New technologies are capable to adjust power settings;
- USB Type C allows for smart charging and is energy-efficient;
- Work is ongoing to make USB Type C fully compliant with the Radio Equipment Directive.

The final remarks on potential standardisation solutions were the following:

- It is difficult to estimate any impact if no clear option is defined;
- An intervention would be justifiable only in the presence of a significant market failure;
- In general, voluntary agreements within the industry should be preferred;
- The only satisfactory option would be to standardise the cable at the EPS side;
- There may be an impact on international trade under WTO rules;
- Some unintended negative consequences would be:
  - Increased e-waste;
  - Decreased innovation;
  - Competition distortion;
  - Consumer choice restriction;
  - Increase in size, weight, and cost of chargers;
- Illicit market expansion.
Annex C: Consumer panel survey synopsis report

The Consumer Survey (CS) was carried out in June 2019 and collected responses from a little over 5,000 respondents across 10 different European countries.

The CS was conducted as part of a wider impact assessment seeking to investigate the interoperability of mobile phone chargers within the European Union and inform the European Commission as to whether any action to promote harmonisation of mobile phone chargers is necessary.

This survey collected information about the type of mobile phones and chargers used by consumers, their degree of interoperability, consumers' experience with charging solutions and the extent to which consumers have encountered problems when using mobile phone chargers.

Methodology

The CS was based on a sample of 10 European countries, each with 500 respondents who were recruited through Ipsos' online consumer panel. The achieved sample included a total of 5,002 survey participants living in the Czech Republic, Germany, Spain, France, Hungary, Italy, the Netherlands, Poland, Romania, and Sweden.68

The selection of countries included in the survey represented 58% of the entire EU population69 and sought to account for a variety of EU-28 consumer markets with different affluence levels70. The panels of respondents were broadly representative of the population of the 10 countries in terms of key characteristics of interest (age, gender, region).

The survey comprised of six different sections covering the type of mobile chargers in use, their nature of use (whether they are only used for the mobile phone they were sold with or if they were with other devices), their average lifetime, consumer preferences, consumer detriment caused by problems related to the use of chargers, and the level of consumer confidence/experience.

Overview of the respondents

A total of 5,002 respondents distributed equally among 10 countries participated in the survey. The respondent's age groups were heterogeneous. The chart below presents an overview of respondents by age band.
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.

### Overview of consumer characteristics relative to mobile phones

#### Mobile phones used

Consumers participating in the interview were asked to list up to two mobile phones (e.g., a personal device and a work device) that they were using at the time of the survey. The most popular brand among consumers was Samsung (36%), followed by Apple (19%), and Huawei (16%).

Figure 38: Please provide the brand of the mobile phone you are currently using most often

Whereas 6% of Samsung users and 2% of Huawei users declared that they also owned an Apple phone, only 1 in 10 Apple users owned a mobile phone of another brand.
Apple phones are most popular amongst the youngest respondents included in the sample when compared to other age bands, on par with Samsung phones. For all other age brackets, Samsung devices are more popular.

Figure 39: Please provide the brand of the mobile phone you are currently using most often

![Brand of Mobile Phone Market Share](chart)

**Source:** Ipsos consumer survey (2019); N=5002

Number of phone chargers used

Survey participants stated using an average of two mobile phone chargers. There were no notable differences by age group.

Number of phone chargers owned

The survey continued by asking respondents about the number of mobile phone chargers owned – i.e. irrespective of whether they were used or not. On average, respondents reported that they own three chargers.

Chargers supplied with mobile phones

80% of respondents indicated that the main charger they were using had been provided with their current mobile phone, whilst 32% reported that they were using the charger provided with their current mobile phone as 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. Only 8% of respondents had bought separately their main charger, 28% had bought their secondary charger separately, and 37% had bought separately an additional charger.
Figure 40: For each charger, can you please tell me whether they were supplied together with a mobile phone?

![Graph showing the percentage of chargers provided with different scenarios]

Source: Ipsos consumer survey (2019). N=5002

Reason for not purchasing a mobile phone charger in the 5 years prior to the consumer survey

45% of all respondents never purchased a charger in the 5 years prior to the survey. 93% of respondents indicated that they were supplied with a new charger when purchasing a new phone and for this reason they did not purchase another mobile phone charger in the 5 years prior to the survey. 13% indicated that they were able to re-use a charger from a previous phone, while 7% used a charger from a device of another type.

Types of connectors on the device (phone) end

Further questions were aimed at presenting an overview of the type of chargers that respondents normally used with their phones. 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%). Moreover, 54% of respondents aged 18 to 24 reported using USB Type C connectivity compared to only 27% of those aged 65 and over. This could be due to a higher propensity of younger people to purchase newer or more high-end mobile phones which are more likely to incorporate this technology.

Types of connectors on the EPS end

Respondents were then asked about the EPS' connectivity characteristics. In this case, USB A is the most common connector (82%), with 7% and 3% of respondents reporting Type C or both USB A and USB Type C connectivity, respectively.71

Total charging time

In terms of charging times, 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% claimed that their phone took more than 3 hours to charge. The fact

71 However, it must be noted that 7% of respondents reported having a different, unspecified type of connection.
that the respondents may have more than one charger or one phone results in having some respondents that indicate different charging times.

Fast-charging EPS

When asked whether their EPS had fast charging capabilities, 72% of respondents stated this was not a current feature, and 54% stated that it was. 38% were unclear whether it was. When multiple chargers were owned, secondary and tertiary chargers were less likely to be fast-charging enabled (decreasing from 36% for the primary charger, to 28% for the tertiary charger).72

Use of chargers

Interoperability of chargers

Respondents were then presented questions related to the extent to which they take advantage of the interoperability of the chargers that they use. 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; younger people (18-24) were more likely to do so (19%) relative to people aged 65 and over (11%). A minority of respondents (14%) used their mobile phone chargers with other electronic devices; in this case, no clear pattern emerges when considering age bands. Among those who utilised their phone charger for other devices, 65% used it to charge tablets. Interoperability with other devices appears limited; only 19% charged wireless speakers with their mobile phone charger and 18% e-readers. iPhone users seem to be more likely to use their phone charger with tablets (75%) compared to non-iPhone users (62%). Yet, non-iPhone users tend to use their mobile phone charger more for e-readers (21% vs 9%). Only 3% of respondents indicated that they were able to charge their laptops with their phone chargers.

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, results are more mixed: 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

Among those respondents who used their phone charger to charge other phones, 26% reported had recollection of performance issues when using their primary charger to charge other mobile phones. However, iPhone users were more likely (32%) to indicate that the charging speed was not affected if they used another Apple charger to charge their

72 It must be noted that 23% of respondents were unable to indicate whether their charger was fast-charging enabled; uncertainty is homogeneous across all age groups.
phones, compared to non-iPhone users who indicated that the charging speed was not affected when using another charger from the same brand as their mobile phone (19%).

Figure 41: Does your charger provide charging at the same charging speed when charging other phones?

Source: Ipsos consumer survey (2019). N=1206

**Consumer habits**

**Purchase frequency of new mobile phones**

In the 5 years prior to the survey, one third of participants purchased a new phone every 2 years, while 25% bought a new mobile every 3 years. Participants aged 18 to 25 are more likely to replace their mobile phone every year than those aged 65 and older (14 and 4% respectively).

Figure 42: In the past 5 years, how often have you acquired a new mobile phone for personal use?

Source: Ipsos consumer survey (2019). N=5002

**Purchase frequency of new phone chargers**

Purchasing new chargers separately from a mobile phone seems more infrequent than purchasing new mobile phones. 48% of non-iPhone users and 33% of iPhone owners did not purchase any charger in the 5 years prior to the survey. However, there seems to be a difference by age; 15% those aged 18 to 24 bought a charger every year, compared to only 3% of those aged 65 and above.
Figure 43: In the past 5 years, how often have you purchased a new mobile phone charger separately?

![Graph showing purchase frequency of new chargers]

Source: Ipsos consumer survey (2019). N=5002

Reasons for purchasing a new charger

A broken mobile phone 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 and needing 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 the reason for buying a charger was that their phone did not come with a charger.

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 they were mainly using at the time.

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 two most important factors underpinning the choice of charger where compatibility with the mobile phone in use (56% of cases among those who had purchased a new mobile phone charger in the previous 5 years) and price (41%). The time a charger would take to fully charge the phone was indicated as important by 18% of those who had purchased a new mobile phone charger. 18% also paid attention to whether the charger had safety certifications. Interoperability of the charger with other electronic devices was considered important by 12%. Other elements were considered of less importance: lifetime of charger (11%), a charger matching the phone brand (10%), wattage (6%), multi-port functions (5%), and weight (2%), or any other elements (3%).

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.

Charger accessories

51% of respondents make use of charger accessories, whilst 46% do not, and 3% do not know. However, most of those who have a charging accessory have a power bank (34%) or multi-port charger (12%). 11% have fast-charging accessories, and 8% wireless charging accessories.

Among those that possess a fast-charging device, 36% own one because they were in a bundle with the phone, whereas 25% bought one exclusively for faster charging. Wireless charging was included in the phone package in 12% of cases, while 32% bought a wireless charger for convenience. Convenience was also indicated as the reason behind the purchase of power banks (38%).

**Consumer preferences**

**Willingness to buy a phone without a charger**

Respondents were also asked whether they would consider buying a phone without a charger (meaning without EPS and cable). 40% of respondents were not willing to buy a new mobile phone without a charger in the box. 45% of respondents were willing to buy only a phone without charger, but as a result of this, 36% indicated that they would expect a discount on the price of the mobile phone. 11% indicated to expect a reduction of either 20 or 50 Euros; 8% considered that 30 Euros was an adequate discount, 7% would have been satisfied with a 10-Euro discount. Only 9% of participants would buy a phone without a charger without monetary compensation. However, the share of undecided respondents is high (14%). Although there are no clear differences between iPhone and non-iPhone owners, younger individuals are generally more willing to accept a discount rather than buying a new phone together with a new charger.

Among those who were unwilling to consider buying a phone without a charger, 68% indicated that the charger provided with the new phone saved the trouble of finding the right charger. The bundle was also perceived as an assurance that the charger would work properly (38%), that it was safe because from the same brand as the phone (35%), and that it would charge the mobile phone efficiently (23%).

55% of those that would consider buying a phone without a charger would do so for environmental reasons, as they indicated that it would help them to save resources and reduce e-waste. Having too many chargers was indicated as a reason for not buying a phone and a charger together by 46% of respondents, while 40% would prefer buying only the phone with an expected price reduction.

**Willingness to buy a phone without an EPS**

Respondents were also asked whether they would consider buying a phone with only a charging cable provided, but without an EPS. 36% indicated that they 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 be willing to 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.
Among those that would not like to buy a phone with only a charging cable, but without EPS, 61% explained that they would not want to worry about how they could charge the phone. 37% indicated that having cable and EPS ensures that the power supply works well, and 26% that performance standards are unaffected. 10% would prefer buying a phone with neither the cable nor the EPS, and 5% had other reasons.

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.

Conjoint experiment

Respondents where then asked to indicate their preferred mobile phone chargers based on a choice of chargers with a combination of different attributes. This conjoint module allowed to identify the elements of a mobile phone charger that consumers perceived as more important relative to other features, which then would be used to model the monetary premium that consumers were willing to pay for the improvement of certain of these mobile phone chargers attributes.

Thus, the conjoint experiment provides a measure of the relative utilities (or importance) of a set list of relevant mobile phone characteristics based on the preferences expressed by a group of 4,906 respondents.

It appears that price was the single most important factor when choosing a mobile phone charger (32% of relative importance), followed by the type of connector on the EPS and on the device side (26% relative importance). Charging time was the third-most important feature that consumers considered when choosing a charger (16% relative importance). Brand had 11% of relative importance, followed by interoperability with other electronic devices other than mobile phones (10% of relative importance). The least important factor among those that consumers were presented with was interoperability across different types of mobile phones (6% of relative importance).

Problems with chargers

Frequency of problems

A further set of questions investigated the nature and frequency of problems encountered by consumers in the use of mobile phone 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.

- The inconvenience of not being able to use a previous charger to charge a new phone was experienced once or twice by 14% of respondents. 14% reported that the problem occurred a few times, on numerous occasions at 10% and almost daily at 9%). 53% of participants experienced no problems of this nature.

- Difficulties in charging other devices with the primary phone charger occurred once or twice for 14% of respondents, a few times for 20%, 10% of respondents on numerous occasions and 5% nearly daily. Half of those participating reported no experience of problems occurring.

- Chargers taking up space at home or at work was indicated as an issue occurring 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.
Preference for using an older charger despite being provided a new one with every new phone was indicated as a problem which had occurred once or twice by 15% of respondents, a few times by 13%, on numerous occasions by 7%, and almost every day by 4%. 60% never experienced this problem.

In terms of charging speed, problems arose once or twice for 18% of respondents. 24% of consumers experienced this problem on a few occasions when they tried to charge their phones with other chargers. 9% reported problems on several occasions and 2% almost daily. However, 47% indicated that they had never experienced problems in the reference period.

Confusion over which charger to use for other electronic devices was indicated as a problem occurring almost every day by 1% of respondents, by 5% on numerous occasions, by 14% a few times, by 15% once or twice, and never by 65%.

Safety issues were also indicated as a problem by 30% of respondents, although they tended to occur with low frequency: 15% once or twice, 11% a few times, 4% on numerous occasions, and 1% almost daily.

Confusion over which charger to use for different mobile phones was a problem for 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 of other chargers.

Other problems affected 23% of respondents.
Figure 44: How frequently have you experienced these problems in the past 24 months with a mobile phone charger you have been using?

<table>
<thead>
<tr>
<th>Problem</th>
<th>Almost every day</th>
<th>On numerous occasions</th>
<th>On a few occasions</th>
<th>Once or twice</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>I couldn’t charge my new phone with my old charger</td>
<td>9%</td>
<td>9%</td>
<td>14%</td>
<td>14%</td>
<td>56%</td>
</tr>
<tr>
<td>I couldn’t charge other electronic devices with my charger</td>
<td>5%</td>
<td>10%</td>
<td>20%</td>
<td>14%</td>
<td>51%</td>
</tr>
<tr>
<td>I have too many chargers taking up space in my home and/or workplace</td>
<td>5%</td>
<td>11%</td>
<td>20%</td>
<td>16%</td>
<td>47%</td>
</tr>
<tr>
<td>I was provided a new charger with a new phone although I would have preferred to use a charger I already had</td>
<td>7%</td>
<td>13%</td>
<td>15%</td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td>Other problems</td>
<td>6%</td>
<td>7%</td>
<td>7%</td>
<td>77%</td>
<td></td>
</tr>
<tr>
<td>I couldn’t charge my mobile phone as fast with other chargers as with my charger</td>
<td>8%</td>
<td>24%</td>
<td>18%</td>
<td>47%</td>
<td></td>
</tr>
<tr>
<td>I was confused which charger to use for which other portable electronic device</td>
<td>5%</td>
<td>14%</td>
<td>15%</td>
<td>65%</td>
<td></td>
</tr>
<tr>
<td>The charger became unsafe to use</td>
<td>4%</td>
<td>11%</td>
<td>15%</td>
<td>69%</td>
<td></td>
</tr>
<tr>
<td>I was confused which charger to use for which mobile phone</td>
<td>5%</td>
<td>12%</td>
<td>13%</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>I needed to charge my phone, but the available chargers were incompatible with my phone</td>
<td>15%</td>
<td>19%</td>
<td>62%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Ipsos consumer survey (2019). N=5002

Severity of problems

The severity of these problems was further investigated among all respondents.

- Considerable inconveniences relative to charging speeds when using other chargers regularly affected 4% of all respondents, whilst significant issues were experienced from time to time by 17% of respondents. 31% of respondents, although being affected by this problem, did not consider it serious.

- Having too many chargers taking up space at home or in the workplace caused significant issues on a regular basis to 6% of all respondents. 15% considered it a problem causing significant issues only from time to time. 31% of respondents, despite that they had experienced this issue, did not consider it as a serious problem.

- Being unable to charge other electronic devices with the main phone charger seemed to be a significant problem occurring on a regular basis for 6% of all respondents. 15% found this to cause significant issues from time to time, whilst 28% did not consider it a serious problem.

- 6% of all respondents indicated that being unable to charge their new phone with an old charger was perceived a serious problem on a regular basis. The problem was still significant, but only occurred from time
to time, for 15% of respondents, 25% of respondents still experienced this problem but did not consider it serious.

- Being provided with a new charger with every phone purchased although one would have preferred to use an old charger was indicated as a problem causing significant issues on a regular basis by 4% of all respondents. 11% considered it a significant problem from time to time, whilst 25% deemed it to be a problem that did not cause any significant issues.

- Not being able to charge a mobile phone because all the available chargers were incompatible was reported as a significant issue occurring on a regular basis by 4% of all respondents, whilst 15% of respondents indicated that incompatibility of phone chargers was a significant issue from time to time. Although 19% of respondents experienced this issue, they did not consider it a serious problem.

- Being confused about which charger to use for other portable electronic devices was considered a significant problem happening regularly by 4% of all respondents. 14% reported that it caused them significant issues from time to time. 18% experienced this problem but did not find it serious.

- 3% of all respondents who indicated that they were confused about which charger to use for which mobile phone considered this as a significant issue on a regular basis. 12% of respondents were significantly affected by this problem from time to time, whilst 15%, despite having experienced it, did not consider this as a serious problem.

- 5% of all respondents found that having a charger that became unsafe to use was regularly a significant problem. 14% considered this a problem causing significant issues from time to time, whilst for 11% of respondents it has been a problem without significant consequences.

- Other problems were perceived as significant by 1% of all respondent, who had experienced them from time to time. Another 1% had had significant problems of other nature but they were not considered serious.
Figure 45: How serious were these problems for you?

<table>
<thead>
<tr>
<th>Problem</th>
<th>Percentage</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>I couldn't charge my mobile phone as fast with other chargers as with my charger</td>
<td>31%</td>
<td>17%</td>
<td>4%</td>
<td>4%</td>
<td>47%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have too many chargers taking up space in my home and/or workplace</td>
<td>31%</td>
<td>15%</td>
<td>6%</td>
<td>6%</td>
<td>47%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I couldn't charge other electronic devices with my charger</td>
<td>28%</td>
<td>15%</td>
<td>6%</td>
<td>6%</td>
<td>51%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I couldn't charge my new phone with my old charger</td>
<td>25%</td>
<td>15%</td>
<td>6%</td>
<td>6%</td>
<td>54%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was provided a new charger with a new phone although I would have preferred to use a charger I already had</td>
<td>25%</td>
<td>11%</td>
<td>4%</td>
<td>4%</td>
<td>60%</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>I needed to charge my phone, but the available chargers were incompatible with my phone</td>
<td>19%</td>
<td>15%</td>
<td>4%</td>
<td>4%</td>
<td>62%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was confused which charger to use for which other portable electronic device</td>
<td>18%</td>
<td>14%</td>
<td>4%</td>
<td>4%</td>
<td>65%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was confused which charger to use for which mobile phone</td>
<td>15%</td>
<td>12%</td>
<td>3%</td>
<td>5%</td>
<td>70%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The charger became unsafe to use</td>
<td>11%</td>
<td>14%</td>
<td>5%</td>
<td>5%</td>
<td>69%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other problems</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>98%</td>
</tr>
</tbody>
</table>

- It didn't cause any significant issues and I do not consider it a serious problem
- It did cause significant issues from time to time
- It caused me significant issues on a regular basis
- It was not a problem

Source: Ipsos consumer survey (2019). N=5002

Responses to problems

When problems arose, nearly one third of respondents (36%) tended to take no action. 27% of participants resorted to using another charger that they already had, while 17% purchased a new one. 7% formally requested a replacement, 7% returned the charger to the place where they had bought it, 7% bought an adapter, 5% asked for a refund, 4% asked for a price discount, and 3% made a complaint to the place where they bought the charger. 1% took other measures, whilst 2% did not recollect what their actions were.

For those that indicated no action was taken, the single main explanation for this was that the problem was not perceived as serious enough (50%). The perception that any action would take an excessive amount of time and effort was a deterrent for 20% of respondents. Other reasons presented as response options, such as not knowing how to complain or not wanting to wait, were all reported at 6% or below.
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).

When asked to quantify these costs, average expenditure for stationery, postage, or calls was indicated at 52 Euros, with a peak of 73 Euros among those aged 35 to 44 and 67 Euros for those aged 25 to 34.

Repairing or resolving the problems at own expenses was reported having an average cost of 31 Euros, with a peak of 47 Euros among the 35-44 cohort, followed by 34 Euros paid by those aged 18 to 24.

The average loss of financial earnings from work stood on average at 57 Euros. The impact was greatest among the younger group (18-24 year-olds), followed by the group aged 55 to 64. Those aged 25 to 34 indicated the loss at 59 Euros, and those aged 45 to 54 estimated the loss to be 18 Euros. The oldest cohort (65+) considered that the problems had caused a loss estimated in 8 Euros.

1 in 4 respondents experiencing problems spent time trying to fix the problems experienced with their chargers for an average of 6 hours.

Persistence of problems

At the end of the CS, respondents were asked whether the problems they had experienced had been resolved fully or in part. For all the issues previously discussed, most respondents indicated that the problems were at least partially resolved.

Being unable to charge a phone because all the available chargers are incompatible was considered a completely resolved issue by 48% of respondents who had experienced this problem, partly resolved by 32%, and not resolved by 12%. The remaining share of respondents either refused to answer or did not know how to answer.

Among those who had experienced lower speed when charging a phone with other chargers, 43% considered the problem completely resolved, 30% as partly resolved, and 14% as unresolved.

Being unable to charge other electronic devices with a mobile phone charger was considered a resolved problem by 40% of those who had experienced it, a partly-resolved problem by 24%, and an unresolved problem by 21%.

Being unable to charge a new phone with an older charger was indicated as completely resolved by 48% of respondents who had indicated having this problem, as partly resolved by 20%, as unresolved by 20%.

Being provided with a new charger when purchasing a new phone although one would have preferred using a previous charger was considered as a resolved issue by 46% of those who had had this problem, partly resolved by 20%, and unresolved by 19%.

Among those who complained about having too many chargers taking up space at home or at work, 28% judged the problem as resolved, 29% as partly resolved, and 30% as unresolved.
Being confused over which mobile phone charger to use for which mobile phone was a resolved problem for 42%, a partly resolved problem for 32%, and an unresolved issue for 14%.

The problem of being confused over which chargers to use for other portable electronic devices was considered resolved by 42% of those who had had this problem, whilst 33% considered it partly resolved, and 13% not resolved at all.

The fact that the charger had become unsafe to use was not a problem anymore for 49% of those who had experienced it, for 25% was a partly resolved issue, and for 12% was not resolved.
Annex D: Market data and information on other portable electronic devices

The following pages contain relevant information and data on a number of types of portable electronic devices, based on a review of publicly available market data and a desk-based review of key characteristics of a sample of products in each category.

1. Smartphones

Product characteristics

Description of the product

Smartphones are mobile phones with computer features, generally based on an operating system. In addition to a set of core functionalities that are typical of mobile phones, such as making and receiving phone calls or sending text messages through cellular networks, smartphones also allow the user to utilise internet-based services and multimedia functions.

Charging characteristics of the product

Based on a review of a sample of 10 popular smartphone models from various brands, we have observed that smartphones require a minimum of 1A and 5V (total of 5W) and a maximum of 2.5A and 12V (total of 18W).

All the 10 smartphones in the sample were sold with both the EPS and the charging cable in the box. Most of the mobile phones in the sample (7 out of 10) were based on USB Type C connectors, two had USB micro B connectors, and 1 had a Lighting connector.

Table 33: Smartphone charging characteristics

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
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<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Smartphones</td>
<td>2.5A</td>
<td>1A</td>
<td>12V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18W</td>
</tr>
</tbody>
</table>


Market characteristics

Data sources

Data is based on an estimation of total mobile phone sales in the European Union drawing on the results of the Stock Model presented as part of this study.

Location of manufacturers

There is a small number of manufacturers of mobile phones based in Europe: BQ is based in Spain, Brondi in Italy, Fairphone in the Netherlands, Gigaset in Germany, Lumigon in Denmark, and Nokia in Finland. Other manufacturers are headquartered mainly in Asia (China, Japan, South Korea, and Taiwan) and in the United States.
Data on market trends

As illustrated in Figure 46, smartphone sales across the EU have gradually decreased between 2008 and 2018, apart from a stationary period between 2012 and 2015. From the peak of 261 million sales in 2008, smartphone units sold appear to have decreased almost 40% over a decade, standing at 158 million in 2018, the lowest in a decade.

Figure 46: Smartphone sales in the European Union

Source: Ipsos own estimation from Stock Model (2019).
2. Tablets

Product characteristics

Description of the product

Tablets are electronic devices that are normally larger in size than a smartphone, but smaller than a laptop. Tablets often run an operating system that allows them to perform computer-like functions and have different types of connectivity: Bluetooth, Wi-Fi, or 4G, or any of the previous types combined, depending on the product.

Charging characteristics of the product

The 11 tablets in the market sample examined for this study require a minimum current of 1 A and 3.76V of voltage (total of 9.36W) and a maximum of 3.25A and 20V (total of 65W).

All the devices in the sample had both the EPS and the cable in the box. There is no clear prevalence of one type of connectors over the others on the device side: 4 have proprietary connectors (including 2 Lightning) and 3 have USB micro B, whilst 3 tablets have instead USB Type C. No information is available on the connector of the remaining tablet.

Table 34: Comparison of charging characteristics between tablets and smartphones

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<th>Current</th>
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<td>Max</td>
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<td>Max</td>
</tr>
<tr>
<td>Tablets</td>
<td>3.25A</td>
<td>1A</td>
<td>20V</td>
</tr>
<tr>
<td>Smartphones</td>
<td>2.5A</td>
<td>1A</td>
<td>12V</td>
</tr>
</tbody>
</table>


Market characteristics

Data sources

Strategy Analytics provides market research information on ITC-related firms and markets. Data on tablet shipments is sourced from a series of press releases and covers the first quarter of each year between 2015 and 2019. However, data is only available for shipments in the world, with no geographical breakdown.

Data on tablets was not available from Comtrade or other public databases on international trade due to the inexistence of a TARIC specific code for this type of devices. The study team was not able to find public data on shipments of tablets to the EU.

Location of manufacturers

Tablets manufacturers are mainly based in Asia or in the United States.
Data on market trends

According to data from the Consumer Survey conducted by Ipsos, tablets may be the most popular portable device after smartphones, as 65% of the respondents that use their mobile phone chargers to charge also other devices use them to charge tablets.

Strategy Analytics' data provides an overview of tablet shipments by manufacturer at the global level between 2015 and 2019, as shown in Figure 47.

Figure 47: Tablet worldwide shipments


Note: Data is only presented for the first quarter of each year for reasons of consistency and is provisional for years 2017, 2018, and 2019.

Figures are available for five main manufacturers: Amazon, Apple, Huawei, Lenovo, and Samsung. Apple seems to be the largest manufacturer of tablets among the five brands, with shipments being consistently higher than any other competitor in the sample between 2015 and 2019. In the first quarter of 2015 worldwide shipments of tablets peaked at 41.8 million and declined gradually until the first quarter of 2019, when sales were expected to increase, reaching 22.8 million units. Apple was the market leader throughout the period included in the analysis, followed by Samsung, which was reported consistently as the second-largest manufacturer in terms of shipments.

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3. E-readers

**Product characteristics**

Description of the product

E-readers, also known as e-book readers, are devices designed for the purpose of reading e-books, newspapers, and other documents. E-readers screens are often based on electronic ink technology, generally requiring less power to function compared to other touch screen technology, but they are also less sensitive to tactile inputs compared to other devices such as tablets and smartphones.

Charging characteristics of the product

In the sample of 8 e-readers included in the analysis, the lowest charging current is 0.5 A and the lowest voltage 3.7 V (for a total power of 10 W), whilst the highest current is 2.5 A and the highest voltage is 5.35 V (for a total of 12.5 W).

7 out of the 8 e-readers in the sample were sold with only the charging cable in the box, without the EPS, and the majority (7 out of 8) have a micro USB connector, whilst only 1 has a USB Type C connector.

Table 35: Comparison of charging characteristics between e-readers and smartphones

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<th>Current</th>
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<tbody>
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<td></td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>E-readers</td>
<td>2.5 A</td>
<td>0.5 A</td>
<td>5.35 V</td>
</tr>
<tr>
<td>Smartphones</td>
<td>2.5 A</td>
<td>1 A</td>
<td>12 V</td>
</tr>
</tbody>
</table>


**Market characteristics**

Data sources

Data from Statista, cited in Vrethager (2017), shows worldwide sales of e-readers between 2010 and 2015.

Data on e-reader imports for the European Union was available from Comtrade, although it was limited to value of imports. However, the product code used might also include other devices alongside e-readers, although it seems reasonable to assume that e-readers constitute the majority of the products in this category.

Location of manufacturers

Manufacturers of e-readers are mainly headquartered in Asia, Canada, and the United States. Booken, an e-book reader manufacturer, is based in France. Another manufacturer, reMarkable, is based in Norway.
Data on market trends

As shown in Figure 48, data on units sold across the world between 2010 and 2015 suggests that the market grew rapidly between 2010 and 2011 (surging from 10.4 million units in 2010 to 37.9 million units in 2011). The peak was reached in 2012 with 40 million units sold; after 2012, the trend was downwards up to 2015, the latest available year, where sales stood at 20.2 million units.

Figure 48: E-readers worldwide sales

![Graph showing e-reader sales from 2010 to 2015.]

Source: Vrethager (2017). The future of the book industry. Note: Figures are based on Statista data.

Data from Comtrade in Figure 49 shows a clear upward trend in the market for e-readers between 2009 and 2014, when the total value of imports into the EU was over 4.8 billion dollars, followed by a gradual decrease in total value of imports until 2018, when the total value stood at 3.9 billion dollars.

Figure 49: E-readers imports into the European Union

![Graph showing e-reader imports into the EU from 2007 to 2018.]

Source: Comtrade (2019). Note: TARIC code 8543700500: Reporter: EU-28; partner: All the world.

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77 The product code used (847130) includes also other devices alongside e-readers.
4. Wearables

Product characteristics

Description of the product

Wearables, or wearable technology, are terms used to identify a set of devices such as smartwatches, smart glasses, or headphones that can be worn on the body and offer a variety of different functionalities depending on the type of device.

Charging characteristics of the product

Among the sample of 15 wearables analysed, including earpods, smartwatches, and smart glasses, it was found that the minimum charging current is 0.1A and the minimum voltage is 3.7V (total of 0.7W). The maximum current is 2A and the voltage 9V (total of 10W).

All the 15 wearables analysed were sold together with a charging cable, but 8 were sold without an EPS. 6 of the 15 wearable devices in the sample, in fact, have proprietary connectors (including one that has Lightning). The remaining devices have either USB micro B connectors (7 devices), USB Type C (1), and 1 device is charged using wireless technology.

Table 36: Comparison of charging characteristics between wearables and smartphones

<table>
<thead>
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<th>Current</th>
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<td></td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Wearables</td>
<td>2A</td>
<td>0.1A</td>
<td>9V</td>
</tr>
<tr>
<td>Smartphones</td>
<td>2.5A</td>
<td>1A</td>
<td>12V</td>
</tr>
</tbody>
</table>


Market characteristics

Data sources

Data on wearables is obtained from a selection of press releases dealing with forecasted worldwide shipments for the years 2017-2022 published by Gartner, a consultancy and market research firm specialised in the digital sector.

Official data on imports of smartwatches into the EU is obtained from Comtrade. However, the product code used to analyse the smartwatch market also contains data on digital watches, and no further distinction is possible. In addition to this, data from Comtrade is only available for smartwatches, as there are no TARIC codes for other types of wearables.

Location of manufacturers

Manufacturers of wearable technologies are mainly headquartered in the United States and in Asia. One manufacturer of wearable sport equipment, Polar Electro, is located in Finland.
Data on market trends

Forecast data released by Gartner reported in Figure 50 show generalised upward trends for shipments of wearable devices between 2017 and 2022. Smartwatches were the leading segment of the market between 2017 and 2019, with 41.5 million and 74 million of items shipped in the two years respectively. However, shipments of earpods and similar technologies which, according to forecasts, totalled 18.6 million units shipped in 2017 and reached 46.1 million units in 2019, were expected to surge and reach 158.4 million of units in 2022 globally. Twenty million units of virtual-reality headset were forecasted to be sold in 2017, increasing to 34.8 million in 2019, and 80.1 million in 2022. More modest shipment growth was recorded for sport watches; units shipped worldwide were forecasted at 18.6 million in 2017, 21.3 million in 2019, and 27.7 million in 2022. Smart clothing, expected to have sold 4.1 units in 2017, then 6.9 units in 2019, and 19.9 million units in 2022.

Figure 50: Wearables worldwide shipments

Data from Comtrade in Figure 51 illustrates that imported quantities of smartwatches (together with digital watches) grew considerably between 2013 and 2016, reaching 28.8 million units. The value of imports peaked in 2015, at 261 million dollars, and then dropped to 109 million dollars in 2017, the latest available year.

Source: Gartner (2018)76.
Note: Data for 2019 and 2022 is forecast.

Figure 51: Smartwatch imports into the European Union

Source: Comtrade (2019).

Note: TARIC code 9102120000; Reporter: EU-28; partner: All the world.

77 The product code used also includes normal watches.
5. Digital cameras

**Product characteristics**

Description of the product

Digital cameras are devices that normally have built-in lenses and allow to take photos and videos with either automatic or adjustable settings. The two main types of cameras are compact cameras and DSLR cameras. Compact cameras (or point-and-shoot cameras) have fixed lenses and basic functions. DSLR (digital single-lens reflex) cameras have interchangeable lenses and offer more advanced features. Another type of cameras are sport cameras (or action cameras), which are dealt with in a separate section.

Charging characteristics of the product

Among the 12 digital cameras included in the analysis, the lowest current needed by a device to charge was 0.2A and the voltage was 3.6V (for a total of 1W), whereas the highest current was 1.89A and the voltage 8.4V (total of 10W).

For all those cameras in the sample for which information was found (11 out of 12), the box included both the EPS and the charging cable. 1 of the cameras had a USB Type C connector, 2 had a proprietary connector, and the remaining 9 cameras had a USB micro B connector.

Table 37: Comparison of charging characteristics between digital cameras and smartphones

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>Voltage</th>
<th>Power</th>
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<tbody>
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<td></td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Digital cameras</td>
<td>1.89A</td>
<td>0.2A</td>
<td>8.4V</td>
</tr>
<tr>
<td>Smartphones</td>
<td>2.5A</td>
<td>1A</td>
<td>12V</td>
</tr>
</tbody>
</table>


**Market characteristics**

Data sources

One source of data at the global and European level are the reports released by the Camera & Imaging Products Association (CIPA), an association of manufacturers of digital cameras based in Japan that represents some of the most prominent Japanese camera manufacturers (including Canon, Casio, Nikon, Panasonic, Ricoh, Sony) and is supported by other international companies (such as Apple, Huawei, and Samsung Electronics).

In addition to this, Comtrade data is used to analyse import quantities into the European Union.

Location of manufacturers

Most manufacturers of digital cameras have their headquarters in Asia (China, Japan, South Korea, Taiwan) and in the United States. Two digital camera manufacturers (Leica, Medion) are based in Germany.
Data on market trends

According to annual data released by CIPA based on information provided by its members, compact digital camera shipments towards Europe declined starting from 2010, until they reached 37 million, to 5.9 million in 2018, as shown in Figure 52.

Figure 52: Digital camera (fixed-lens) shipments to Europe

The decline shown by CIPA’s figures is consistent with import data released by Comtrade in Figure 53. Import quantities into the European Union reached their highest point in 2010, at 131.7 million units, and declined to less than half in the following years, standing at 54.2 million units in 2017. The total value of imports fell from 8 billion dollars in 2010 to 5 billion dollars in 2017.

Figure 53: Digital camera imports into the European Union

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6. Sport cameras

Product characteristics

Description of the product

Sport cameras, also known as action cameras, are small cameras that can be attached to a person's body or to sport equipment (e.g. to a bike, a motorbike, or a helmet), allowing to film or take photos hands-free by using automatic settings. Certain action cameras can be used also in extreme conditions (e.g. underwater).

Charging characteristics of the product

In a review of 12 action cameras conducted for this study, the minimum current required was 1A and the minimum voltage was 3.6V. The maximum current was 2A and the maximum voltage was 5V. The total power required ranged between 1.3W and 10W.

8 out of 12 action cameras in the sample were sold with a charging cable, but without EPS. 5 utilised USB micro B connectors, 4 USB Type C, and 3 USB mini B.

Table 38: Comparison of charging characteristics between sport cameras and smartphones

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<tr>
<th></th>
<th>Current</th>
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<th>Power</th>
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<tr>
<td></td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Sport cameras</td>
<td>3.25A</td>
<td>1A</td>
<td>20V</td>
</tr>
<tr>
<td>Smartphones</td>
<td>2.5A</td>
<td>1A</td>
<td>12V</td>
</tr>
</tbody>
</table>


Market characteristics

Data sources

Comtrade reports statistics related to cameras that can be used for aerial filming on drones, underwater, or other similar uses. It can be assumed that most of the products in this category are sports cameras. No other more specific source was found.

Location of manufacturers

Manufacturers of sport cameras have their headquarters mainly in Asia or in the United States. No European manufacturers of action cameras were found.

Data on market trends

Figure 54 shows that in 2008 the total value of shipments stood at USD 13.6 million, reaching a peak in 2014, at USD 15.8 million, and touching the sum of USD 11.3 million in 2017. While import quantities in 2017 were only 4% of the quantity of cameras imported in 2008, the total value of imports was 83% of the value in 2008.
Figure 54: Sport camera imports into the European Union

Source: Comtrade (2019).
Note: TARIC code 9006300000; Reporter: EU-28; partner: All the world.

79 Import quantities for 2013 not available.
7. Videogame devices

Product characteristics

Description of the product

Videogames consoles, accessories, and controllers comprise a series of battery-operated, handheld devices which are utilised to play videogames.

Charging characteristics of the product

In a sample of 8 controllers, virtual reality headsets, and console devices reviewed for this study, the current ranges between 0.8A and 3A, whilst the voltage spans 3.65V to 15V (total power between 3W and 20W).

When information about decoupling was available (6 out of 8 devices), it was found that all the videogame consoles and controllers were sold with both EPS and cable. USB micro B was the main type of connector, with only one device using USB Type C and one device using USB mini B.

Table 39: Comparison of charging characteristics between videogame devices and smartphones

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<td></td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Videogame devices</td>
<td>3A</td>
<td>0.8A</td>
<td>15V</td>
</tr>
<tr>
<td>Smartphones</td>
<td>2.5A</td>
<td>1A</td>
<td>12V</td>
</tr>
</tbody>
</table>

Source: Ipsos’s own research (2019) based on a sample of 8 videogame devices.

Market characteristics

Data sources

The first data source used to inform market trends at the global level is derived from Nintendo's publicly-available information on total shipments of their own devices worldwide. Although this offers only a partial view of the global market for videogame consoles, Nintendo is one of the major producers of videogames in the world, with an estimated 22% market share in 2017.

For the European Union, market trends for quantity and value of imports are derived from Comtrade statistics.

Location of manufacturers

No European manufacturers of videogame consoles or controllers were found. Producers are mainly based in Asia (Japan) and in the United States.

Data on market trends

Nintendo data in Figure 55 shows that global shipments peaked around 2009, at 57 million units sold. After 2015, the trend was downwards, but shipments bounced back in 2017, with 10.8 million units shipped worldwide. In 2018, shipments reached 21.4 million units, and decreased slightly in 2019, at 19.5 million.

Figure 55: Nintendo worldwide shipments

Source: Nintendo (2019)\(^81\)

Data from Comtrade presented in Figure 56 shows an irregular pattern when considering import quantities into the European Union. After an increase in imported units in 2014 when videogame consoles imported reached 55 million units, and lower imports in 2015 and 2016, imports reached a peak in 2017 with 59 million units imported into the EU, for a total value of 5 billion.

Figure 56: Videogame consoles imports into the European Union

Source: Comtrade (2019).

Note: TARIC code 9504500000: Reporter: EU-28; partner: All the world.

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\(^{81}\) Figures for 2019 until June.

8. Laptops

Product characteristics

Description of the product

A laptop computer (often referred to also as 'notebook') is a portable computer built in a clamshell comprising a screen, keyboard, trackpad, and generally also speakers, a microphone, a webcam, and various types of connectors. In addition to this, older laptops also included optical disc drivers capable of playing CDs and DVDs.

Charging characteristics of the product

Based on a review of a sample of 11 popular laptops from various brands, we have observed that they require a minimum of 1.5A and 5V (total of 30W) and a maximum of 3.25A and 20V (total of 65W).

All the laptops in the sample analysed were sold with both the EPS and the charging cable in the box. 8 out of 11 laptops had proprietary connectors, whilst 3 had USB Type C connectors.

Table 40: Comparison of charging characteristics between laptops and smartphones

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<thead>
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<th>Current</th>
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<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Laptops</td>
<td>3.25A</td>
<td>1.5A</td>
<td>20V</td>
</tr>
<tr>
<td>Smartphones</td>
<td>2.5A</td>
<td>1A</td>
<td>12V</td>
</tr>
</tbody>
</table>


Market characteristics

Data sources

Data is obtained from Comtrade official statistics describing imports of portable computers into the European Union.

Location of manufacturers

Laptop manufacturers are mainly located in Asia and in the United States. In the European Union, there are two manufacturers headquartered in Germany: Medion and Terra Home Wortmann.

Data on market trends

Comtrade data presented in Figure 57 shows that sales of laptops increased between from 46.6 million units imported in 2009 to 101.7 million units in 2013. Imports slightly decreased in 2014 throughout 2017, when they stood at 74.4 million units. The total value of laptop imports generally followed the same pattern, peaking at over 35 billion dollars in 2014, and then dropping to 27.4 billion dollars in 2017.
Figure 57: Laptop imports into the European Union

Source: Comtrade (2019).
Note: TARIC code 8471300000; Reporter: EU-28; partner: All the world.
Annex E: Supporting data

The stock model, as well as data sheets with the consultation and survey results, will be provided separately in MS Excel format.
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