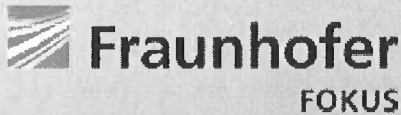


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Trinomics



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Impact Assessment Study on Common Chargers of Portable Devices

Interim Report

Ipsos MORI, Trinomics, Economisti Associati, Fraunhofer FOKUS

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Glossary

Table 1.1: Glossary of terms

Term	Definition
Alternating Current (AC)	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.
Consumer panel	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.
Counterfeit charger	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 fulfil safety requirements, thus posing risks to consumer safety (e.g. risk of causing electrocution, starting a fire).
De-coupling	Sale of mobile phones without including an external power supply
External Power Supply (EPS)	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.
High-end phones	Phones that are amongst the most expensive or advanced in a company's product range, or in the market as a whole.
In-the-box charger	Chargers that are sold together with the mobile phone, when consumers buy a new phone.
Lightning	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.
Low-end phones	Phones that are amongst the cheapest in a company's product range, or in the market as a whole.
Low Voltage Directive	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 designed for use within certain voltage limits.
Memorandum of Understanding (MoU)	Nonbinding agreement between two or more parties outlining the terms and details of an understanding, including each parties' requirements and responsibilities. It expresses a

		convergence of will between the parties, indicating an intended common line of action.
Mobile phone		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.
Radio Equipment Directive		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.
PMA		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.
Preferred Charging Rate		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.
Proprietary charging solution		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.
Qi		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.
Quick Charge		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.
Standalone charger		External power supplies sold on their own, without being part of a full package including a phone (or another device) and the charger
Universal Serial Bus (USB)		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).
USB-IF		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.
USB micro-B		Connector (B-Plug and B-Receptacle) which can be used for charging support and additional functions, whose reference specification is "Universal Serial Bus Cables and Connector Class Document" Revision 2.0 August 2007, by the USB Implementers Forum.

USB Type C	24-pin USB connector system, which is distinguished by its two-fold rotationally-symmetrical connector. A device with a Type-C connector does not necessarily implement USB 3.1, USB Power Delivery, or any Alternate Mode. The Type-C connector is common to several technologies while mandating only a few of them.
USB 3.1	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)
USB 3.2	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).
USB Power Delivery	In July 2012, USB-IF announced the finalization of the USB Power Delivery (PD) specification (USB PD rev. 1), an extension that specifies using certified PD aware USB cables with standard USB Type-A and Type-B connectors to deliver increased power (more than 7.5 W) to devices with larger power demand. The USB Power Delivery specification revision 2.0 (USB PD rev. 2) was released as part of the USB 3.1 suite. It covers the Type-C cable and connector with four power/ground pairs and a separate configuration channel. Revision 3.0 was released in 2017.
USB Fast Chargers	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.
Wireless charging	Inductive charging (also known as wireless charging or cordless charging) 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.
30-pin connector	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.

1 Introduction

This interim report is the **second 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.

The **main purpose of this report** is to present a brief summary of the progress made since the submission and acceptance of the inception report in March 2019. In particular, the report provides:

- An overview of the data collection effort to date (chapter 2).
- A more detailed account of the current situation as regards mobile phone chargers, including further evidence on the nature, scale and scope of the problems and issues that arise from this (chapter 3).
- An identification and justification of the concrete policy options we propose to consider for in-depth analysis during the ensuing stages of the study (chapter 4).
- A brief overview of the key elements of the work plan and milestones for the remainder of the study (chapter 5).

2 Progress to date

Since the submission of the inception report, we have undertaken the following activities:

- **Literature review:** The literature review was initiated in the inception phase. During the data collection phase, we have kept reviewing documentation that has become available or that has been recently identified. This includes: documents and literature provided by interviewees, in-depth review of existing standards (IEC and IEEE) and other technical documents, literature on environmental impacts, and literature on the effects of standardisation on innovation.
- **Review of secondary data on shipments of mobile phones:** Ipsos acquired secondary data from ICD, including data on shipments of mobile phones in 2018 by model, and annual data for certain models of mobile phones (those with charging solutions of particular interest) between 2016 and 2018. Data on shipments has been used inter alia to feed into a stock model aimed to estimate the number of chargers that consumers hold, based on a series of assumptions. These assumptions, in turn, have been made based on literature reviewed and the results from the survey to consumers.
- **Public consultation:** The European Commission launched a public consultation on the potential harmonisation of mobile phone chargers. The consultation was launched on 14 May, and will remain open until 6 August 2019. At the time of writing, 821 responses had been received.
- **Consumer panel survey in 10 EU countries:** A survey was launched in early June 2019 to a panel of consumers across 10 EU Member States (Czech Republic, Germany, France, Italy, Poland, Spain, Hungary, The Netherlands, Romania and Sweden). We received 500 answers per country, totalling 5,000 responses. The panels used for the survey are broadly representative of the population of the countries in question as regards key characteristics of interest (including age, gender, region, market size, working status and level of education). Data included in this report is based on a preliminary analysis of the results. However, weighting may still need to be applied, and cross-tabulations created to understand patterns among groups of consumers. Final results, hence, may differ from the data presented in this report.
- **Stakeholder interviews:** In total, 23 interviews have been conducted, and three other interviews are scheduled to take place shortly. Our target is to conduct up to 45 interviews during the data collection phase. We have organised the interviews in batches, so that we can prompt and contrast hypothesis and investigation lines throughout the mainstage period. In addition, contacting certain groups of interviews depends on others providing information. For example, mobile phone manufacturers are expected to provide details on their suppliers and distributors. Subsequently, charger manufacturers are expected to provide details about manufacturers of other devices using the same chargers they manufacture for mobile phones. In practical terms this means, for instance, that interviews with manufacturers of other devices have not been conducted yet. However, it should be taken into consideration that manufacturers of mobile phones also produce other devices, and therefore we have been able to gather views on other devices through them. Industry associations have also fed into this part of the analysis. The table below summarises the interviews conducted per type of stakeholder, and compares these figures to our target.

Table 1. Interviews conducted per type of stakeholder

Type of stakeholder	Target	Conducted	Rejected*
European Parliament	2	1	3
Standardisation bodies	3	3	1
National authorities	5	1	0
Mobile phone manufacturers	10	5	1
Charger manufacturers	6	1	0
Industry associations	2	1	0
Manufacturers of other devices	4	0	0
Other industry	5	3	0
Distributors	3	2	1
Consumer organisations	2	3	0
Environmental NGOs / Experts on environmental impacts	2	2	2
Product safety organisations	1	1	0
Total	45	23	8

**Rejected includes only those stakeholders who have been contacted and have replied rejecting their participation in the consultation. It does not include stakeholders who have not replied to our request.*

3 The current situation

This chapter provides a summary of the evidence we have compiled to date on the current situation regarding chargers for mobile phones and (where relevant) other portable electronic devices, in order to further describe and substantiate the nature and scale of the problem to be addressed by the initiative, clarify the baseline situation, and introduce key technological aspects that could be considered for further harmonisation. It draws on data and information from a range of different sources, including existing data, statistics and literature, and primary data from the interviews and consumer survey.

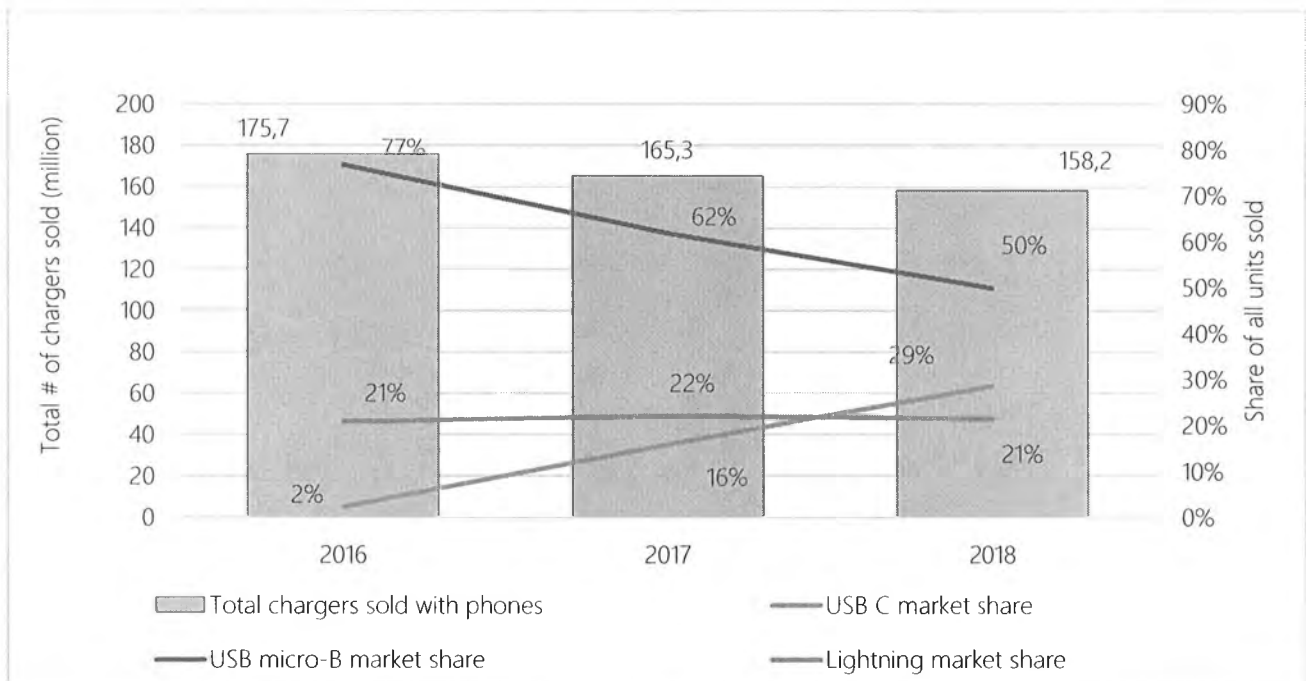
3.1 The market for mobile phone chargers

Market trends 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 158 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 1 below shows how the market shares for charging technologies – i.e. the connectors at the device end – has changed from 2016-2018.

Figure 1: Mobile phone chargers sold with mobile phones (2016-18, 24 EU Member States)



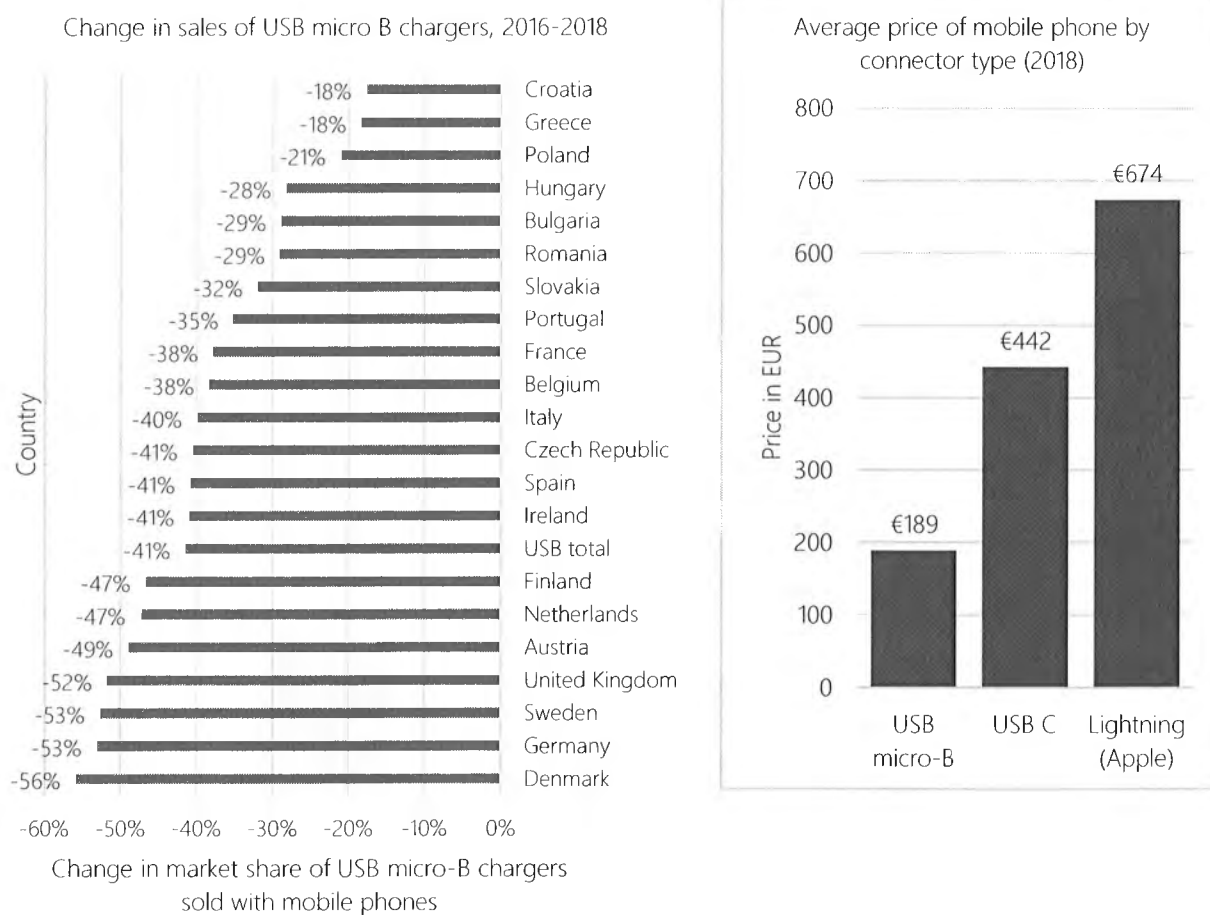
Source: IDC Quarterly Mobile Phone Tracker, Q1 2019

Note: Data excludes standalone chargers. Data covers UK, Germany, France, Italy, Spain, Poland, Netherlands, Romania, Sweden, Portugal, Hungary, Belgium, Austria, Czech Republic, Denmark, Greece, Finland, Ireland, Bulgaria, Slovakia, Croatia, Luxembourg, Malta and Cyprus.

The market share of chargers using Lightning connectors has stayed relatively consistent over the period from 2016 to 2018 (slightly above 20%), even though the number of units sold over this period has consistently declined. 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%).

Figure 2: Sales trends and average prices by connector types



Source: IDC Quarterly Mobile Phone Tracker, Q1 2019

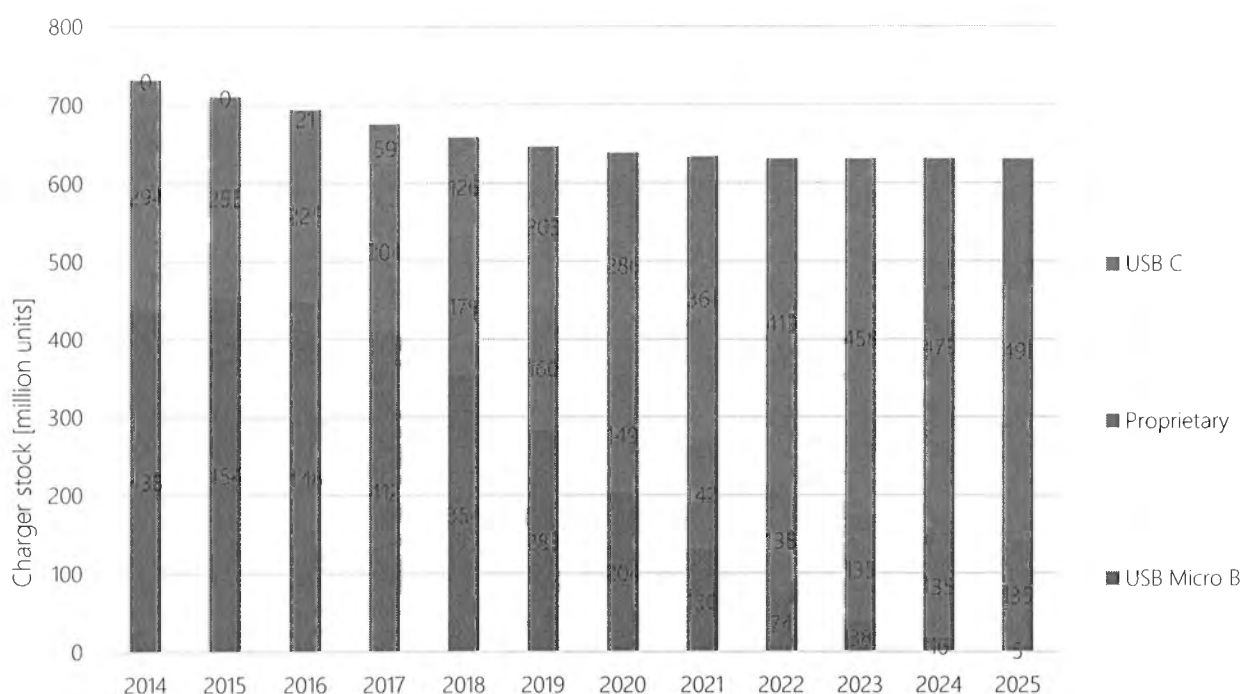
Note: Data excludes standalone chargers. IDC data does not include separate counts for Malta, Luxembourg or Cyprus. Shipments for these countries are included under Italy, Belgium and Greece respectively.

Figure 3: Fast charging solutions sold with a mobile phone 2016-18, 24 EU Member States

The current and future stock of phone chargers

We have developed and populated a stock model for chargers based on detailed smartphone sales data and initial assumptions (see below) on other additions and removals from the number of chargers in use each year. The results presented in Figure 5 show the estimated evolution in the number of chargers between 2014 and 2025. These show a slowly declining stock of chargers until 2020, consistent with the slow decline in smartphone sales also observed in the EU28 in recent years. The split between connector types shows how from 2018 onwards USB-C connector chargers are expected to continue their growth and dominate the charger stock, primarily replacing the standard USB Micro B type chargers of the previous MoU. Numbers of proprietary chargers (primarily Apple) also decline slowly over the period as the overall market shrinks and due to declining market share in recent years. In any case, around 600-750 million chargers are estimated to be in circulation at any one point in time¹.

Figure 5: Stock of chargers in EU, split by connector (device-side) type, 2014-2025



Source: Own calculations based on data from IDC and Statcounter.

These estimates are based on a number of assumptions including:

- Total sales and market shares are held constant from 2018.
- Based on unweighted data from our consumer survey (n=5,002) 20% of phone chargers in use were bought separately from phones, a corresponding amount is added to the chargers stock each year.

¹ The RPA (2014) report does not directly refer to a stock of chargers in circulation, although it does refer to stocks of mobile phones numbering around 600-650 million in the years 2011-2013.

- Distribution profiles of chargers (per connector type) are constructed for the 10 largest manufacturers, based on actual data on connector types for 2016-2018, and with trends extrapolated before and after these years. These result in 100% USB C for most manufacturers by 2021 or 2022, except for Apple which is expected to retain its proprietary solution.
- Charger disposals are modelled over the course of 6 years proportional to smartphone sales. Unweighted data from responses to a question in our consumer survey on the frequency of smartphone purchases is used to allocate disposals over time, effectively linking the disposal decision to the purchase of a new phone. We used further unweighted data from the consumer survey to establish that around 73% of chargers are kept in the stock one way or another at each time point, whilst the remaining 27% of chargers are disposed (20% recycled, 7% in general waste). For the chargers that are retained we assume these are disposed in a future year, assuming 11.5% are disposed each year, and the remainder in the final (T+6) year. Proportionally this results in the following disposal trend over time, showing most chargers are assumed to be disposed of after 2-3 years. This is consistent with RPA (2014), and an average period of 2.37 years before charger disposal.

Table 1: Assumed annual disposal rates for mobile phone chargers

Year>	T=0 (charger purchase)	T+1	T+2	T+3	T+4	T+5	T+6
% of chargers disposed in year	12%	13%	19%	16%	12%	11%	17%
Cumulative % of chargers disposed since year of sale	12%	25%	44%	60%	72%	83%	100%

3.2 Key technological aspects

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, a technical assessment of the extent to which other portable devices may have charging solutions that are interoperable with mobile phones, 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 it depends on the type of battery and the recharge time. Interoperability, in summary, relies on the following:

- EPS providing the current and voltage that the battery needs, determined by the battery's charging profile;
- A cable connecting the EPS to the device supporting the power being transmitted, with plugs (connectors) at both ends 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 external power supply (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.²

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 1.5 A), new technologies emerged to cover this need. For example, in 2013 Qualcomm released Quick Charge 2.0³, which provided maximum power of 18W by increasing the current and the voltage of the common charger. Since then, Qualcomm has released 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-IF⁴, 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 2018 the standard series IEC 62680. This standard series set the specifications for USB Power Delivery (IEC 62680-1-2:2018) and USB Type C (IEC 62680-1-3:2018).

The USB 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 are already incorporating USB PD in their devices, such as Apple, Google, and Huawei. Samsung has recently announced new charging solutions based on USB PD.

The USB C specification is intended as a supplement to the existing USB 2.0, USB 3.1 and USB Power Delivery specifications. It defines the USB Type-C receptacles, plugs and cable assemblies. This specification also sets charging requirements up to 15 W, 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 63002:2016. 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. Unlike other standards, IEC 63002 does not have a certification process.

² 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

³ Presentation prepared by Qualcomm for a meeting with the European Commission, DG GROW, on 8 September 2016

⁴ 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".

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

Type of EPS	Specifications applicable	Interoperability with low-end phones	Interoperability with high-end phones
Common EPS, as defined in 2009 MoU	IEC 62684:2018	Yes	It can charge high-end phones at a normal speed
USB PD	IEC 62680-1-2:2018 IEC 62680-1-3:2018 IEC 63002:2016	Yes	Yes
Quick Charge v1, v2, v3	None	Yes, although safety (for user and device) is not guaranteed	Only phones including Quick Charge
Quick Charge v4, v4+	Programmable Power Supply Compatible with USB PD and USB C specifications	Yes	Yes

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 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 C. USB 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 a few months later. 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. The exception is Apple’s proprietary connector, Lightning, which has been incorporated in all iPhones, iPads and iPods since 2012. Some other devices launched recently by Apple, however, include USB 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).

Other portable devices

The current (measured in ampere) and the voltage (measured in volts) are two key parameters that define any electrical circuit. The power (measured in watts) is a third parameter that also characterises the 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 (i.e. USB cable) must be also compliant with communication protocols to guarantee a safe transmission of data.

Smartphones' charging power typically ranges between 5W and 15W. Devices with similar characteristics are, for instance, e-readers, wearables, and cameras, as illustrated in Table 2. Laptops, however, require more power, which poses technical challenges to share the EPS with a mobile phone. USB PD offers enough power as to charge laptops. However, given that mobile phones typically do not need so much power, the chargers included in the box do not provide the power that laptops need. This means that while these chargers can charge a laptop, they would need longer to reach full charge. On the other hand, the chargers included in the box with the laptops could charge mobile phones using only the power required by the mobile phone, and ensuring a safe charge for both the user and the device. If laptops were to be included within the scope of the new regulation or voluntary agreement, the mandated charger might need to support higher power capacity than what mobile phones typically need.

Another challenge to ensure interoperability between the charging solutions of mobile phones and other devices is the connector at the device end. Certain devices require connectors with specific characteristics to meet the functions the device is designed for. This is the case, for instance, of wearables that are submersible, 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 C (or other types of USB) may not be suitable include: health devices, such as hearing aid devices, household appliances, or some *Internet of Things* devices used in agriculture. These devices frequently use proprietary connectors and, more recently, wireless chargers. A wireless charger is 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. Wireless charging is further discussed in the next sub-section.

Table 2: Typical charging characteristics of portable devices

Device	Current	Voltage	Power
Smartphones	1A – 2A	5V – 12V	5W – 15W
Laptops	2.5A – 3A	19V - 20V	30W – 65W
Tablets	2.4A – 3.25A	5.1V – 9V	12W – 44W
E-readers	2A – 2.5A	5V – 5.35V	10W – 12.5W
Wearables	1A – 2A	5V	5W – 10W
Cameras	1.5A	5V	7.5W
Sport cameras	0.6A – 2A	3.7V – 5V	2.4W – 10W
Videogames	0.6A – 1A	5V	4.1W – 5W

Source: Ipsos MORI compilation

Wireless charging

Wireless charging is an incipient technology to charge portable devices (incipient meaning that it is currently situated at the beginning of the life cycle). At the moment, its energy efficiency is around 60%, whereas energy efficiency for wired technologies is close to 100%.⁵ There are three main technologies for wireless charging: Airfuel, Qi and PMA.

AirFuel Resonant and Airfuel RF are two technologies developed by Airfuel Alliance, an open standards organisation formed by companies in the field of consumer electronics and mobile technology. Qi and PMA, however, seem to have been so far the preferred technologies by mobile manufacturers. 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.⁶ Wireless chargers only work with compatible devices. The iPhone X, iPhone 8, and many Android phones, including Huawei, allow wireless charging. As shown in Section 3.1, we estimate that in 2018, around 28% of mobile phones sold in the EU were wireless enabled.

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 Consumer (in)convenience

Unweighted data from the consumer survey undertaken in June 2019 provides initial evidence on the nature and size of potential consumer inconvenience arising from the current level of harmonisation of mobile phone chargers. The survey data will be analysed in more detail for the draft final report.

Figure 6 overleaf presents aggregate responses across all respondents to the survey, as to whether they have experienced any of the listed problems with their mobile phone charger in the 24 months prior to the survey.

More than half of all respondents (53%) indicated that to some degree, they had experienced having too many chargers taking up space in their home and/or workspace. 52% of all respondents indicated that they had experienced other chargers not charging their phone as fast as their charger, and 50% indicated that they had experienced their mobile phone charger not being able to charge other electronic devices.

The most often 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 (17%), and not being able to charge other electronic devices with a charger (15%).

Respondents were in turn asked how serious they considered the problems that they experienced with mobile phone chargers. A summary of responses across all respondents who reported problems is presented in Figure 7.

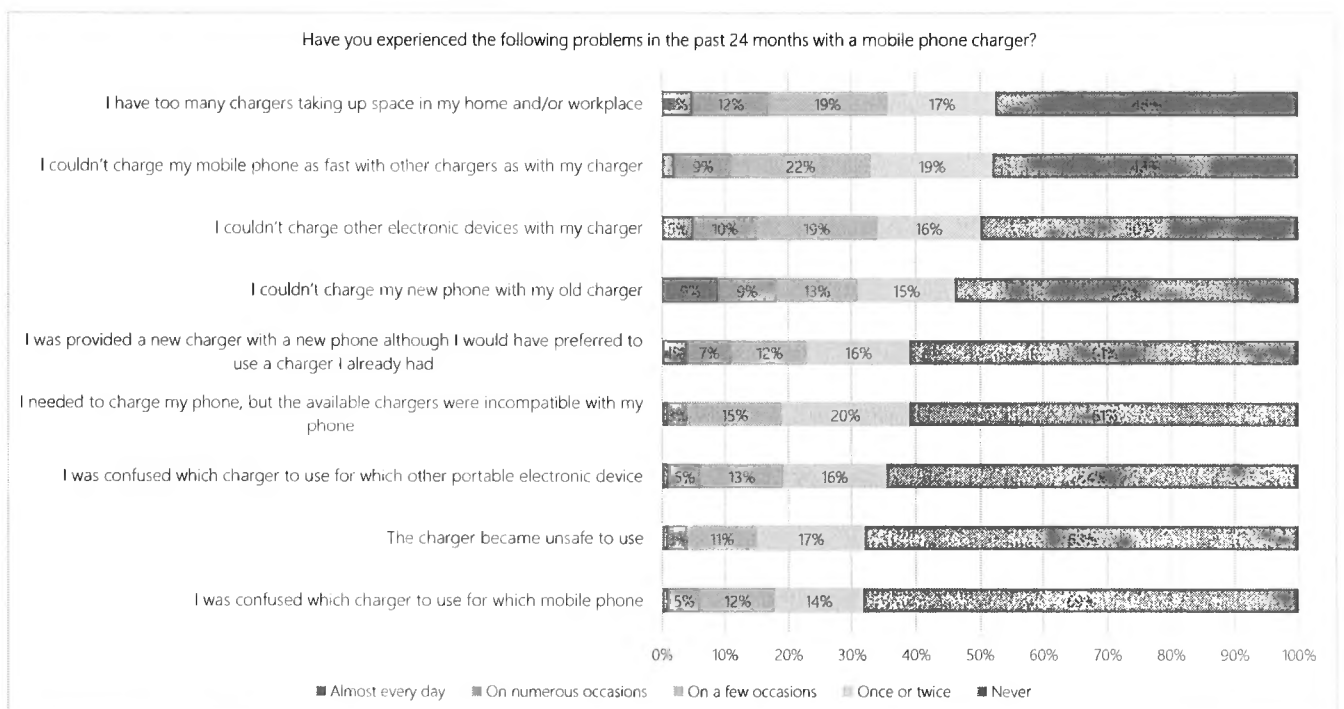
⁵ According to interviews conducted with technical experts.

⁶ Source: <https://qi-wireless-charging.net/qi-enabled-phones/> (accessed on 28 June 2019)

Overall, a minority of those reporting problems considered these to be causing significant issues on a regular basis. The problems most often considered as significant issues on a regular basis included having too many chargers at home and/or the workplace taking up space (309 respondents, or 6% of all 5,002 respondents), not being able to charge a new phone with an old charger (292, 6%), the charger becoming unsafe to use (254, 5%) and not being able to charge other electronic devices with the charger (253, 5%).

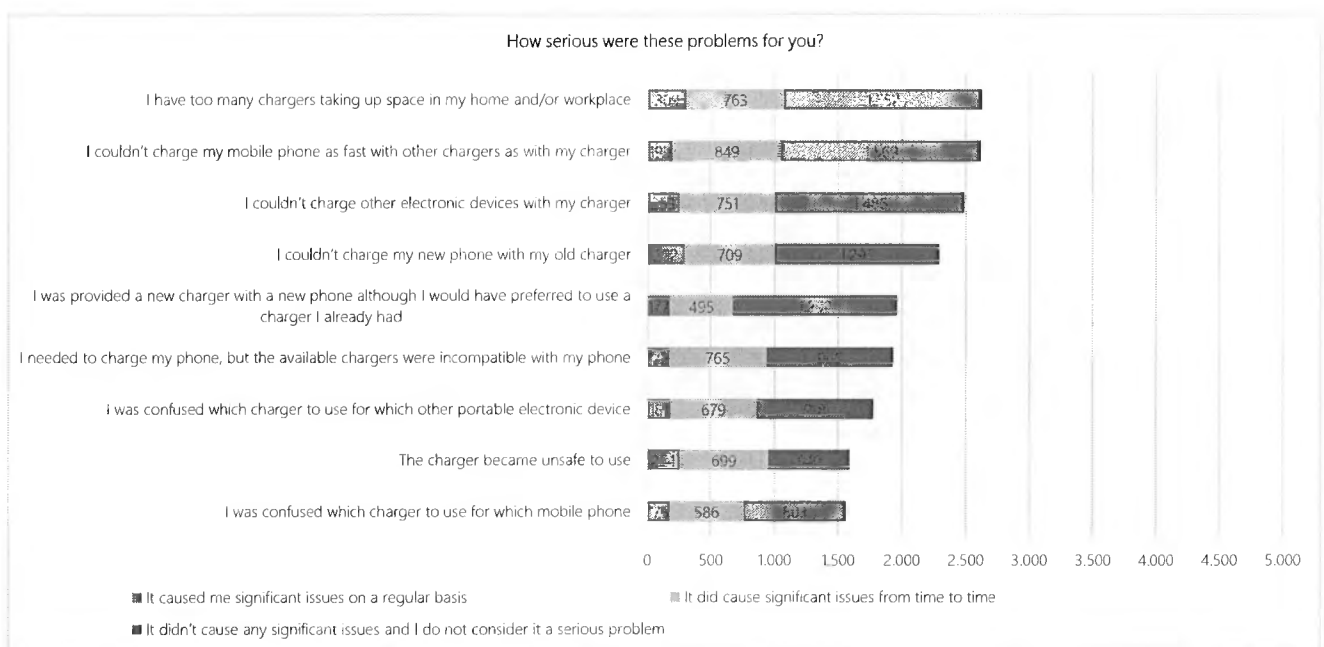
Around a fifth of respondents reported some problems to either be causing significant issues on a regular basis or from time to time. These included having too many chargers at home and/or the workplace taking up space (1,072 respondents, or 21% of all 5,002 respondents), other chargers not charging their phone as fast as their charger (21%), not being able to charge other electronic devices with a charger (20%), not being able to charge a new phone with an old charger (20%), the charger becoming unsafe to use (19%) and being provided a new charger with a new phone although respondents would have preferred to use a charger they already had (19%).

Figure 6: Share of consumers experienced problems with a mobile phone charger



Source: Ipsos (2019); n: 5,002. Note: Data is unweighted and might not be representative of all consumers in the countries surveyed. Countries included in survey: CZ, DE, ES, FR, HU, IT, NL, PL, RO, SE.

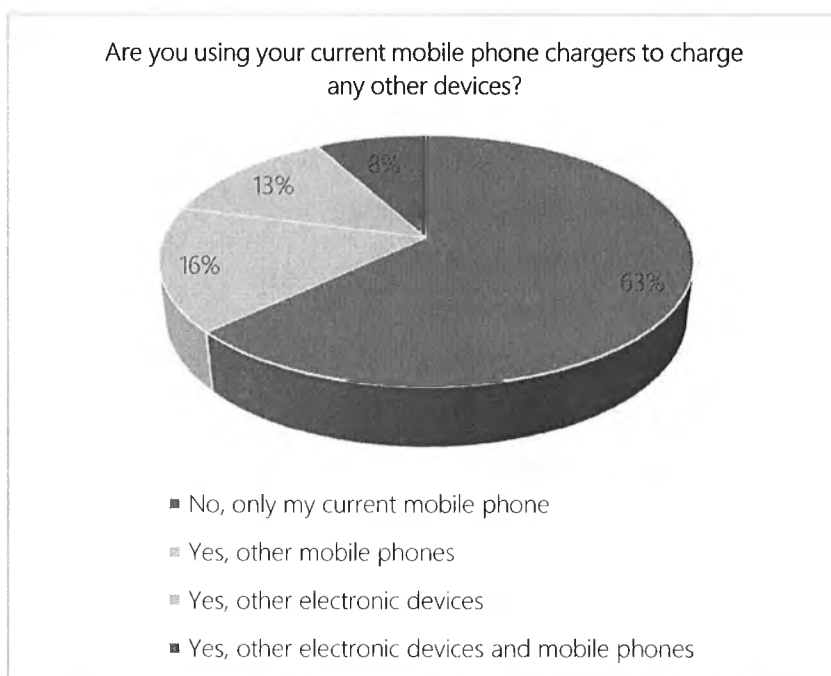
Figure 7: Seriousness of problems experience by consumers



Source: Ipsos (2019); n: 1,564 to 2,624 consumers who experienced problem out of total of 5,002 consumers surveyed. Note: Data is unweighted and might not be representative of all consumers in the countries surveyed. Countries included in survey: CZ, DE, ES, FR, HU, IT, NL, PL, RO, SE.

Respondents to the consumer survey were also asked whether they are using their current mobile phone charger to charge any other devices, to investigate the share of consumers that currently make use of interoperable chargers. Slightly over a third of respondents (37%) reported that they are using their mobile phone charger to charge other devices. Perhaps unsurprisingly, a slightly larger share of respondents use their mobile phone charger to charge other mobile phones (24%) than other electronic devices (21%) – further analysis will investigate to what extent the degree of re-purposing a mobile phone chargers is corresponding with the current level of interoperability between mobile phones and other electronic devices. Out of respondents who did use the mobile phone charger to charge other devices, tablets (63%), wireless speakers (19%), wireless earphones (18%) and e-readers (16%) were most often cited as the other electronic devices charged.

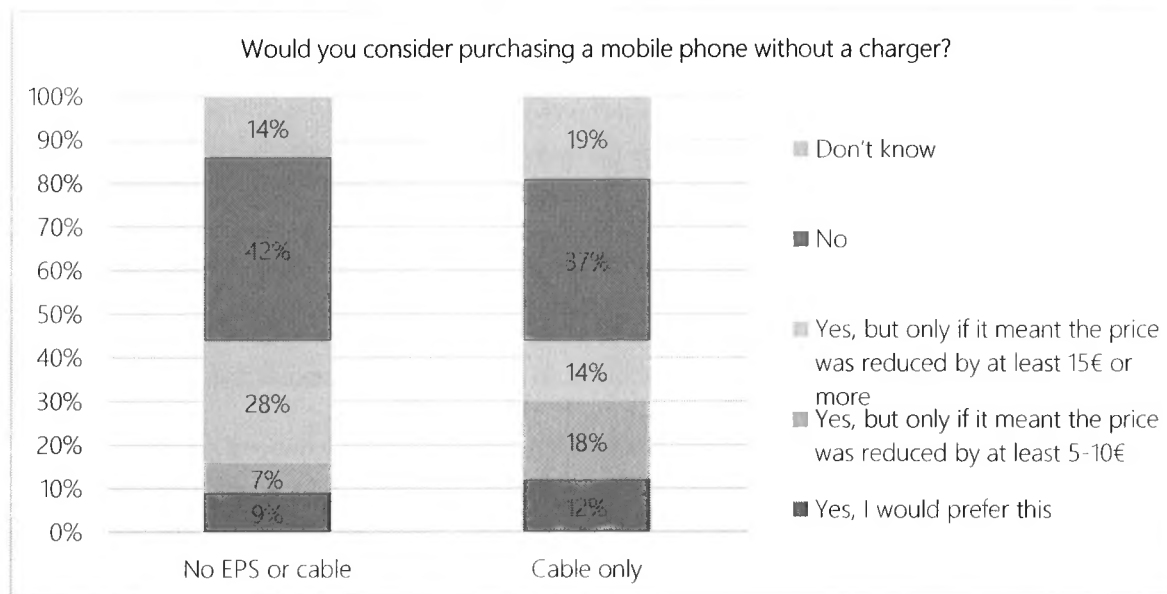
Figure 8: Share of consumers using their mobile phone charger to charge other devices



Source: Ipsos (2019); n: 5,002. Note: Data is unweighted and might not be representative of all consumers in the countries surveyed. Countries included in survey: CZ, DE, ES, FR, HU, IT, NL, PL, RO, SE.

Consumers were also queried about their openness to de-coupling, i.e. purchasing mobile phones without a charger included. 12% of respondents indicated that they would prefer purchasing a mobile phone with a connector cable only, and 9% indicated they would prefer purchasing a mobile phone with neither EPS nor cable included. A larger share of respondents indicated that they might consider purchasing a mobile phone without a charger if this meant a discount on price. Further analysis of the survey data is needed to segment responses, including by the type of phone these respondents are currently using.

Figure 9: Openness of consumers to de-coupling



Source: Ipsos (2019); n: 5,002. Note: Data is unweighted and might not be representative of all consumers in the countries surveyed. Countries included in survey: CZ, DE, ES, FR, HU, IT, NL, PL, RO, SE.

The survey also included a large number of other questions on aspects ranging from the number of chargers respondents possess and use, the features they most value in a charger, the ways in which they dispose of old chargers, etc. The results will be reviewed in detail, and incorporated into the appropriate parts of the analysis.

3.4 Impacts on economic operators

During the interviews conducted to date, industry representatives from across different sectors (industry associations, mobile phone manufacturers, charger manufacturers, and distributors) and standardisation bodies have raised their concerns on the potential impacts on the standardisation of charging solutions. The main concerns raised are related to the technical difficulties of implementing a universal charger, the potential impacts on innovation when it comes to developing new charging solution, and the differences in costs between USB-C and USB-A, and between USB-C and USB micro-B. In addition, they also commented on aspects such as the market for counterfeit and sub-standard products, or consumer convenience.

Technical issues

Industry seems particularly concerned when assessing the possibility of having one charger that can fit all, i.e. one charger with very restrictive characteristics to charge all phones and, potentially, other portable devices. This is due to the technical challenges discussed in section 3.2. In addition, one manufacturer claims that their proprietary plug is better suited to charge their phones, and that using USB-C instead would require profound changes in the design of their phones (mainly due to the bigger size of USB C compared to their proprietary solution). They argue that in those devices for which USB-C is a better option than their proprietary solution, they have already made the shift to USB-C.

Innovation

One of the main arguments expressed by industry representatives against regulation is its potential impact on innovation. Regulation, 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. The fact that a new regulation may include provisions to shift towards new (common) charging methods does not seem to solve this issue, since:

1. There is a possibility that new charging technologies are not developed, or are developed at a slower pace;
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 proprietary charging solutions leading to the next USB generation, a few interviewees commented on the influence of Lightning on the development of USB-C. According to several interviewees, for example the fact that USB-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

Industry representatives, nonetheless, were not the only stakeholders consulted who were concerned about the impact that standardisation may have on innovation. 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, and that has now been replaced by USB-C.

Economic impacts

Innovations, as any new product introduced to the market, follow a life cycle going through the following main phases: introduction, growth, maturity and decline. The phase of a product is directly linked to its price on the market: the earlier in the cycle, the more expensive it typically is. Interviewees consulted for this study agreed that USB-C has not reached the maturity phase yet, but is currently somewhere in between introduction and growth. USB micro-B, on the other hand, is in the decline phase. Difference in cost, hence, is one of the arguments raised by some industry representatives when asked about the reasons why USB-C has not fully superseded USB micro-B yet at the phone end.

Industry claim that a transition period is needed to fully adopt USB C at both ends, the estimated time needed to transition from USB A to USB C being longer than in the case of USB micro-B to USB C. In this regard, it should be noted that USB A can support fast charging, and therefore the advantages of USB C over USB A are not as significant as the advantages of USB C over micro-B. A transition period would allow USB-C to advance through its life cycle more “organically”, and gradually reduce its cost.

Cost was also an argument raised against the possibility of having “one charger that fits all” (potentially meaning both mobile phones and a wide range of other portable electronic devices). If this were the case, the universal charger would need to meet the requirements of the most powerful device, and therefore “the best charger” would need to be provided with all phones, including low-end phones that may not need so high requirements. The cost of this universal charger, they argue, would be higher. On the other hand, it should be noted that a universal charger may lead to economies of scale, and this argument may therefore not hold true entirely.

It should also be noted that one charger manufacturer interviewed raised serious concerns regarding the standardisation for a universal charger. The main activity this company develops is to design chargers meeting certain ad-hoc requirements for the devices they are meant to charge. This company designs chargers in an EU MS and manufactures them elsewhere. In their view, mandating for a single universal charger would put at risk the existence of their company: “if a universal charger was mandated, we would go bust”.

Counterfeit products

The issue of the counterfeit market is discussed further in Section 3.6. From the point of view of economic operators, however, it is worth highlighting a shared concern among some interviewees about the potential increase in counterfeit and sub-standard products⁷ if a common charging solution is mandated. According to these interviewees, a single charger would reduce the entry barriers for this type of products, and therefore be likely to increase their presence in the EU market. This poses concerns not only from the point of view of consumer safety, but also from the perspective of brand reputation. Interviewees argue that those consumers who experience issues with their device due to the use of sub-standard chargers will typically blame the device manufacturer, rather than to the charger manufacturer.

Consumer convenience

Industry representatives identified a number of sources of potential inconvenience for consumers derived from a rapid shift to USB C, listed below:

- On the device end, consumer inconvenience could increase given that interoperability of phones with USB micro-B and Lightning connectors would be reduced;
- At the EPS end, USB A is still the mainstream technology. A rapid shift would imply the current stock of EPS would quickly become obsolete (before the “natural” end of their useful life), which would create inconvenience for consumers, on the one hand, and increase e-waste, on the other hand;

⁷ Counterfeit products exist at all price ranges. They are intended to show the consumer that they are genuine. Sub-standard products, on the other hand, are chargers that do not comply with international standards and/or regulations, and they may or may not be counterfeit.

- If a standard charger is mandated, consumers in the EU may end up having different (and potentially more expensive) charging solutions than in other parts of the world. For example, if new charging solutions are developed, there is a risk that they will be available elsewhere, but not in Europe.

De-coupling

The issue of de-coupling is very much linked to consumer convenience and the counterfeit market. When asked about the reasons why de-coupling has not happened yet, industry argued that consumers expect a charger in the box. In addition, chargers are provided together with mobile phones to avoid consumers using sub-standard chargers that may damage the battery. Finally, higher de-coupling, industry claims, may benefit the counterfeit and sub-standard market.

When asked about the reasons why consumers prefer a charger in the box, responses given were the useful life of the charger, which may need being replaced as frequently as the mobile phone, and the fact that consumers use mobile phone chargers to charge other devices.

3.5 Environmental impacts

The production of each charger (EPS and cable) 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, the more significant these impacts are. Below, we outline the first findings emerging from our literature review and interviews in relation to these aspects.

Material composition 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.

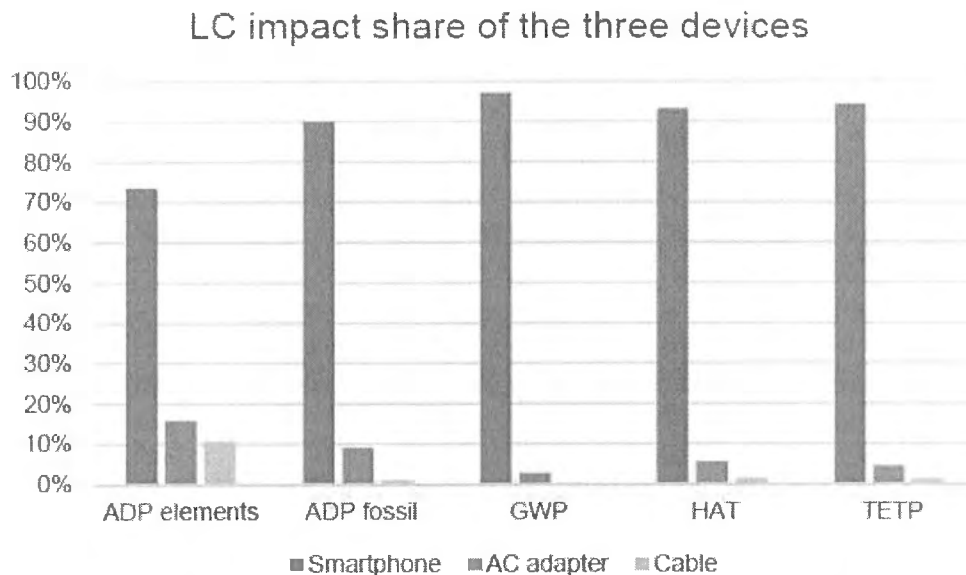
The 2014 RPA study did not investigate the material composition of chargers in detail. It estimated material savings on the basis of an average charger weight of 60g derived from weighing various models. In addition, an assumption was made that around 30% of the content of a charger was from recycled 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 very little tangible difference in volume and type of materials used.
3. The main 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.⁸ 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, charging block (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 10: Share of environmental impacts per device



Source: SustainablySMART (2019) Regulation of Common Chargers for Smartphones and other Compatible Devices: Screening Life Cycle Assessment. Policy

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 IZM⁹, which detailed the main materials contained in the EPS (charging block) and cable as shown in Table 3 below.

⁸ SustainablySMART (2019) Regulation of Common Chargers for Smartphones and other Compatible

Devices: Screening Life Cycle Assessment. Policy Brief No. 2. Available at: https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2018-6427186/feedback/F18050_fr?p_id=342389; Ercan, M. (2013), Global Warming Potential of a Smartphone Using Life Cycle Assessment Methodology, Master of Science Thesis, Royal Institute of Technology, Stockholm. Available at: <http://kth.diva-portal.org/smash/get/diva2:677729/FULLTEXT01.pdf>; Charles River Associates (2015) Harmonising chargers for mobile telephones Impact assessment of options to achieve the harmonisation of chargers for mobile phones

⁹ Provided to the study team by the Horizon 2020 project SustainablySMART

Table 3: Material composition of a Samsung fast charger

Material	Contained in the EPS (weight in grams)	Contained in the cable (weight in grams)
Plastics	19.74	10.20
Copper	0.47	3.22
Steel	0.75	6.98
Ferrite	6.37	
Aluminium ¹⁰	1.7	
Unspecified ¹¹	9.06	
Total weight	38.08	20.40

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

Recyclability of materials

The RPA study¹² 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.¹³

The LCA study performed by Fraunhofer IZM¹⁴ assumes that the two recyclable materials are plastic (Polycarbonates) and copper. Assuming a recovery rate of 0.84 for plastic and 0.92 for copper, the authors estimate that 16.59 g of plastic and 0.43 g of copper can potentially be recycled from a charger.

Based on a sample charger (model not specified), Horta Arduin et al.¹⁵ estimated that the quantity of potentially recyclable materials in 1kg of mobile chargers amounts to 39%. The main recyclable material is copper (27%), followed by plastics (polyethylene and PVC, about 5% each). 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, yet there is no recycling channel in France for this type of plastic originating from WEEE.

On the basis of these reviews we will develop 'environmental profiles' for three different charger types, namely a standard charger, USB-PD fast charger, and QuickCharge fast charger, within the stock model to estimate environmental impacts.

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. The number of chargers on the market and the de-coupling rates that are

¹⁰ We assume that the electrolytic capacitors, which weigh in total 3.4g, are made up of 50% aluminium.

¹¹ Materials contained in some components of the circuit board and transformer

¹² RPA (2014) Study on the Impact of the MoU on Harmonisation of Chargers for Mobile Telephones and to Assess Possible Future Options

¹³ 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/>

¹⁴ SustainablySMART (2019) Regulation of Common Chargers for Smartphones and other Compatible Devices: Screening Life Cycle Assessment

¹⁵ Rachel Horta Arduin, Carole Charbillet, Françoise Berthoud, Nicolas Perry (2016) What are the environmental benefits of increasing the WEEE treatment in France? Proceedings of the Electronics Goes Green 2016+ conference, Berlin, September 7 – 9, 2016.

likely to be achieved determine the amount of e-waste generated (and avoided). However, not all consumers dispose of their old charger as soon as they replace their phone, and not all discarded chargers are properly recycled.

The 2014 RPA study¹⁶ 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 Australia¹⁷.

A literature review finds only limited further supporting information, including a study based on a survey of 150 inhabitants of the city of Oulu, Finland in 2013 which found that 55% of respondents had two or more unused mobile phones at home¹⁸, demonstrating that chargers are often kept for extended periods when not in use and before being disposed of.

The consumer survey asked respondents a specific question on their mobile phone charger disposal methods. The results suggest that most chargers are either in use or retained by users. Of the 27% actually disposed, around 20% are recycled and 7% are disposed of (incorrectly) as general waste¹⁹.

CO₂ emissions and other environmental impacts

The results of several life-cycle assessments of chargers with respect to Global Warming Potential (GWP)²⁰ are shown in the table below. These demonstrate that per weight the EPS has a higher emissions impact than the cable.

Table 4: LCA estimates of embedded CO₂ emissions in chargers

Life-Cycle Phase	Source & charger model	GWP (kg CO ₂ eq.)		
		EPS	Cable	Total charger
Raw material acquisition	Ercan (2013) - Sony Xperia T ²¹	1.18	0.301	1.48
Manufacturing	Ercan (2013) - Sony Xperia T	0.249	0.0432	0.29
	SustainablySMART (2019) - Samsung fast charger (EP-TA20EWE) ²²	0.898	0.096	0.99
	Charles River Associates (2015) - Apple charger (UK plug) ²³	1.85	0.35	2.20
Transport	Ercan (2013) - Sony Xperia T	0.1729 (transport within China) 2.0726 (transport to market, China to Sweden)	0.0692 (transport within China) 0.8290 (transport to market, China to Sweden)	0.24 (transport within China) 2.90 (transport to market, China to Sweden)

¹⁶ RPA (2014) Study on the Impact of the MoU on Harmonisation of Chargers for Mobile Telephones and to Assess Possible Future Options

¹⁷ GSMA (2006): Mobile Phone Lifecycles, available at <http://www.gsma.com/publicpolicy/wp-content/uploads/2012/03/environmobilelifecycles.pdf>

¹⁸ Jenni Ylä-Mella, Riitta L. Keiski, Eva Pongrácz (2013) Electronic waste recovery in Finland: Consumers' perceptions towards recycling and re-use of mobile phones. *Waste Management* 45, pp.374–384.

¹⁹ From consumer survey preliminary results, to be updated.

²⁰ A measure of the amount of heat trapped by a greenhouse gas, relative to CO₂. GWP is therefore expressed in CO₂ equivalents.

²¹ Weight: 60g EPS, 24g cable

²² Weight: 38 EPS, 20g cable

²³ Weight: 28.6 EPS, 17.6 cable

Life-Cycle Phase	Source & charger model	GWP (kg CO ₂ eq.)		
		EPS	Cable	Total charger
	Charles River Associates (2015) - Apple charger (UK plug)	0.775	0.31	1.085
End of Life (metals recovery)	SustainablySMART (2019) - Samsung fast charger (EP-TA20EWE)	0.011	0.005	0.016

Sources: SustainablySMART (2019) *Regulation of Common Chargers for Smartphones and other Compatible Devices: Screening Life Cycle Assessment. Policy Brief No. 2*; Ercan, M. (2013), *Global Warming Potential of a Smartphone Using Life Cycle Assessment Methodology*; Charles River Associates (2015) *Harmonising chargers for mobile telephones Impact assessment of options to achieve the harmonisation of chargers for mobile phones*

Preliminary impact estimates

On the basis of the impacts described above and the stock model, we are able to make some preliminary estimates of the environmental impacts of mobile phone chargers discussed above, under the 'no policy change' (baseline) scenario. As shown in the table below, from 2018 onwards, around 310,000 tonnes of CO₂ per year are produced. Raw material consumption (as well as, consequently, e-waste) amounts to around 13,000 to 14,000 tonnes per year.

Table 5: Initial estimates of environmental impacts of the "business as usual" scenario

Environmental impacts		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CO ₂ emissions	Tonnes CO ₂ generated - Total	230,221	259,005	309,148	293,144	311,553	311,093	311,093	311,093	311,093	311,093	311,093	311,093
	CO ₂ generated - g per charger	1,000	1,148	1,398	1,411	1,502	1,502	1,502	1,502	1,502	1,502	1,502	1,502
Raw material used	Raw material used - Total (tonnes)	11,511	12,308	13,844	13,164	13,948	13,927	13,927	13,927	13,927	13,927	13,927	13,927
	Raw material used - avg. per unit (g)	50	55	63	63	67	67	67	67	67	67	67	67
E-waste	Total E-waste (tonnes)	12,953	12,486	12,356	12,209	12,676	12,954	13,208	13,555	13,829	13,800	13,931	13,927
	Of which recycled (tonnes)	9,671	9,322	9,225	9,115	9,464	9,672	9,861	10,120	10,325	10,303	10,400	10,398
	Of which incorrectly disposed (tonnes)	3,282	3,164	3,131	3,094	3,212	3,283	3,347	3,435	3,504	3,497	3,530	3,529
	Of which from cables (tonnes)	5,181	4,945	4,755	4,529	4,479	4,390	4,300	4,240	4,193	4,146	4,145	4,144
	Of which from EPS (tonnes)	7,772	7,541	7,600	7,680	8,197	8,565	8,908	9,315	9,636	9,654	9,786	9,783

These results are made on the basis of the following key assumptions:

- Recycling rates remain the same over time – we are assessing if this recycling increment can be increased in the future years.
- All chargers are disposed of over the course of 6 years. This is accounted in 2 ways, (1) an assumption, based on the consumer survey, that a proportion of chargers are disposed of at the same time as purchasing a new phone (20% recycled, 7% to general waste); (2) an assumption that 11.5% of the remaining stock of chargers from the same year of sale are disposed of each year for 5 years, until the remainder is disposed of in year 6.

- That chargers have the following characteristics, this includes an assumption that the impact and weight of the cable is identical across chargers, this assumption based on desk review and expert feedback:

Charger type	Standard Charger	Fast charger (USB-PD)	Fast charger (Quickcharge)	Proprietary charger
CO2 emissions per unit (g)	1000	2 000	1 500	1 500
Cable weight (g)	20	20	20	20
EPS weight (g)	30	70	45	35
Total weight (g)	50	90	65	55

3.6 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 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.

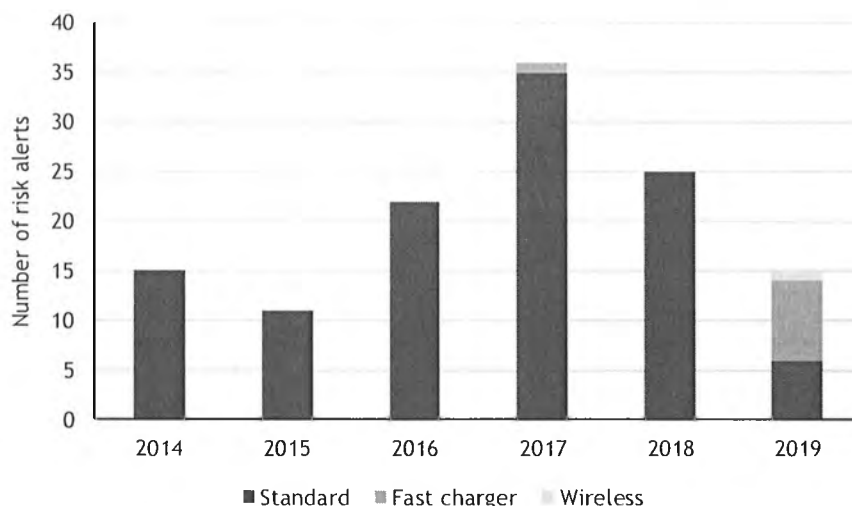
The results of an analysis of the number of risk alerts (serious product risks or other risks) for mobile phone chargers between 2014 and part of 2019 from RAPEX²⁴, indicates that there is an increasing trend in the detection of phone chargers that pose risks to consumers (see Figure 11 below). Most of the alerts were submitted for standard mobile phone chargers, although in recent years risk alerts for fast chargers and wireless chargers have started to appear as well. It should be noted that these alerts only refer to those that are detected by the national authorities and economic operators and that 2019 only includes alerts submitted in the first 5 months of 2019, therefore the number of alerts at the end of 2019 could surpass those of 2018.

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 trend²⁵. It is interesting to observe this increase in a period that also corresponds with reductions in resources at many national inspection and market surveillance authorities in Europe.

²⁴ 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 done 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.

²⁵ There may be some small differences in methodology applied between the 2014 study and this study.

Figure 11: Number of risk alerts in the EU28 for mobile chargers from 2014 to 2019 by type of charger



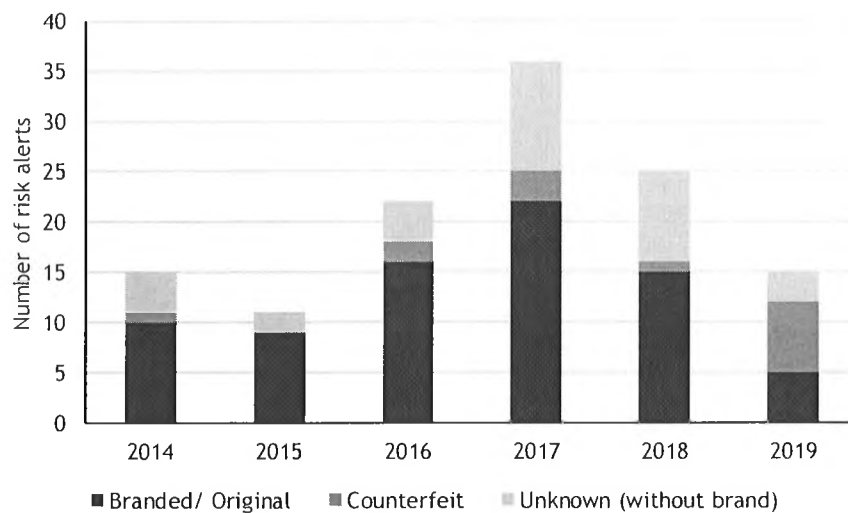
Source: Own elaboration based on the rapid alert system for dangerous non-food products (RAPEX).

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 12. 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 consumers²⁶. 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 tests²⁷.

²⁶ https://euipo.europa.eu/tunnel-web/secure/webdav/guest/document_library/observatory/documents/reports/2019_IP_Crime_Threat_Assessment_Report/2019_IP_Crime_Threat_Assessment_Report.pdf

²⁷ <https://www.electricalsafetyfirst.org.uk/media/1119/counterfeit-and-imitation-apple-chargers.pdf>

Figure 12: Number of risk alerts in the EU28 for mobile chargers from 2014 to 2019 by brand



Source: Own elaboration based on the rapid alert system for dangerous non-food products (RAPEX).

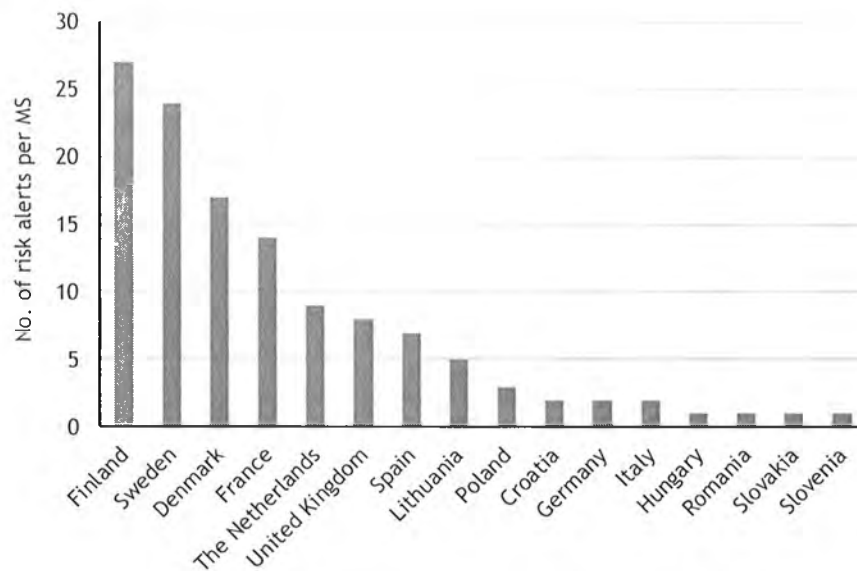
From the RAPEX data, almost all the technical defects that triggered the risk alerts failed to comply with safety requirements of the Low Voltage Directive²⁸, due to one or more of the following technical defects:

- 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.

The Member States that submitted the most alerts to RAPEX were Finland, Sweden, Denmark and France, as shown in Figure 13.

²⁸ 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.

Figure 13: Alerts to RAPEX for chargers per MS (2014-2019)



3.7 The effects of the 2009 Memorandum of Understanding

The 2014 RPA study found that the MoU signed in 2009²⁹ was effective at harmonising charging solutions and improving consumer convenience. The RPA study concluded that “the number of different charging connectors on the market has declined substantially over the period of the MoU and the vast majority of handset owners now have an MoU compliant phone, which enables many to charge their phones using chargers of friends, colleagues, etc.”

Our study has further explored the effectiveness of the 2009 MoU, with the aim of assessing the extent to which the MoU contributed to the take up of USB micro-B and the extent to which EPS are compliant with the IEC 62684 standard. Finally, we provide a preliminary assessment of the problems to be addressed nowadays, if any.³⁰

USB micro-B was developed by the industry, and conversations between industry and the IEC to develop the standard for Micro USB connectors had started before the 2009 MoU was signed, according to the interviewees and the literature reviewed.³¹ While USB micro-B was the natural development for data-enabled mobile phone charging technologies, interviewees agree that the 2009 MoU “boosted” this transition and had a potential impact on the adoption of this technology by manufacturers, including signatories as well as non-signatories. Overall, interviewees agree that the MoU was effective at harmonising charging solutions, while not precluding innovation. In this regard, it should be noted that all

²⁹ The MoU was originally signed by 10 companies, and four other companies signed it later. Original signatories: Motorola, LGE, Samsung, RIM, Nokia, Sony Ericsson, NEC, Apple, Qualcomm and Texas Instruments. Subsequent signatories: Emblaze Mobile, Huawei Technologies, TCT Mobile and Atmel.

³⁰ The size of the problems needs to be further assessed once the survey has been analysed in-depth, estimates for the market have been fine-tuned, and all interviews have been conducted.

³¹ Specifications of Micro USB series were published in 2007 by the USB-IF. The standard developed by IEC is 62680-2. Sources: USB-IF (2007) Universal Serial Bus Cables and Connectors Class Document, Revision 2.0, available at: <https://www.usb.org/sites/default/files/CabConn20.pdf> (accessed on 28 June 2019); and IEC (2013) IEC 62680-2 Universal serial bus interfaces for data and power – Part 2: Universal serial bus – Micro-USB cables and connectors specification, revision 101, available at: <https://www.sis.se/api/document/preview/572356/> (accessed on 28 June 2019).

interviewees consulted agreed that the 2009 MoU did not affect innovation, since it allowed for manufacturers to develop and introduce new solutions to the market while being compliant with the MoU (e.g. Lightning).

According to our estimations, in 2016, two years after the 2009 MoU (and the subsequent letters of intent) had expired, the market share of mobile phones with USB micro-B connectors was 77%. This figure decreased to 50% in 2018, with a directly inverse increase in the market share of USB-C (2% in 2016 and 29% in 2018). The market share of proprietary connectors (Lightning) has remained constant at around 21%. It should be noted that Apple's connector is compliant with the 2009 MoU despite being a proprietary solution. The rapid increase of USB-C connectors in the last three years confirms that the charging solution covered by the 2009 MoU is becoming obsolete, in favour of new technologies.

On the EPS side, data show a sharp increase in the sales of mobile phones and chargers that incorporate fast charging solutions. As per our estimates, total shipments of fast charging enabled devices amounted to 15 million devices in 2016, and this figure increased to around 70 million devices in 2018. This means that the market share of fast charging enabled mobile phones increased from 9% to 44% in only two years. The standard developed by CENELEC, and later published by IEC as IEC 62684 to define the interoperability of common external power supplies for use with data-enabled mobile telephones, is also becoming obsolete, since it does not cover charging interfaces that implement USB C or USB PD technologies.

This study has also explored the effect of these technological changes on consumer convenience, the environment, the economic operators and the illicit market. The table below summarises the current problems to be addressed:

Type of problem	Preliminary assessment
Interoperability of wired charging solutions	<ul style="list-style-type: none"> • USB C, Lightning and micro-B co-exist. While USB micro-B is being superseded by USB C, the market share of mobile phones with Lightning connectors has remained constant in the last 3 years (2016-2018). • Fast charging solutions (USB PD, USB C, and proprietary solutions) have irrupted and increased sharply since 2016. While the market is fragmented (several proprietary and standard solutions), there seems to be a transition towards USB PD and USB C, or proprietary solutions compatible with USB PD. In addition, both USB PD and USB C are backwards compatible.
Interoperability of wireless charging	<ul style="list-style-type: none"> • Similarly, several wireless charging solutions co-exist, the main ones being Airfuel, PMA and Qi. Standardisation bodies consulted foresee new solutions emerging in the near future, with no clear pathway as to which one will be the mainstream solution, if any. • Nowadays, wireless charging enabled phones normally bring Qi, PMA, or both. Wireless chargers are not normally included in the box, and a rapid review of wireless chargers available in the market showed that most of them can charge phones that are either Qi or PMA enabled. • It is important to note that wireless technologies, unlike wired charging, are not mutually exclusive. This means that both phones and chargers can support several technologies at the same time, increasing interoperability.

Type of problem	Preliminary assessment
Consumer convenience	<ul style="list-style-type: none"> Main problems highlighted by consumers are having too many chargers taking up space in their home and/or workspace other chargers not charging their phone as fast as their charger, and inability of their mobile phone charger to charge other electronic devices. However, only a minority of those reporting problems considered these to be causing significant issues on a regular basis.³²
Environment	<ul style="list-style-type: none"> Mobile phone chargers continue to generate around 13,000 tonnes of e-waste per year, most of which is due to the EPS rather than the cable, mainly due to its greater weight. EPS supporting fast charging generate slightly more e-waste and CO₂ emissions per unit than standard chargers. Ultimately, the impact of any policy option on the environment will depend on de-coupling rates. The consumer survey showed that 42% of consumers would not consider buying a mobile phone that does not include a charger in the box, even if the price was reduced (this percentage was reduced to 37% when asking about including the cable only).
Illicit market	<ul style="list-style-type: none"> Counterfeit and sub-standard chargers may cause health and safety issues, and may damage the devices. Safety is particularly a problem in the case of standalone chargers. A contributory factor is the growth in online purchases sent direct to consumers which are more difficult to regulate and where counterfeit and sub-standard products are more common. Industry claim that harmonisation of chargers reduces entry barriers for illicit products.
Economic impacts, including innovation	<ul style="list-style-type: none"> Interviewees agreed that the 2009 MoU did not preclude innovation. However, most industry interviewees are concerned that a regulatory option may do so, as it would reduce incentives to invest in new charging technologies. A grace period is needed, industry argue, to allow for a smooth transition to USB C. This argument will need to be analysed and compared with the survey results and the analysis of environmental impacts.

In conclusion, this study will need to assess the trade-offs between different policy options and the likely impacts that different solutions would entail. For example, while de-coupling has the potential to decrease e-waste and CO₂ emissions, it might contribute to increase the number of counterfeit and sub-standard chargers in the market, or be detrimental for consumer convenience.

³² Data from the consumer survey need to be further analysed in order to quantify the size of the problem.

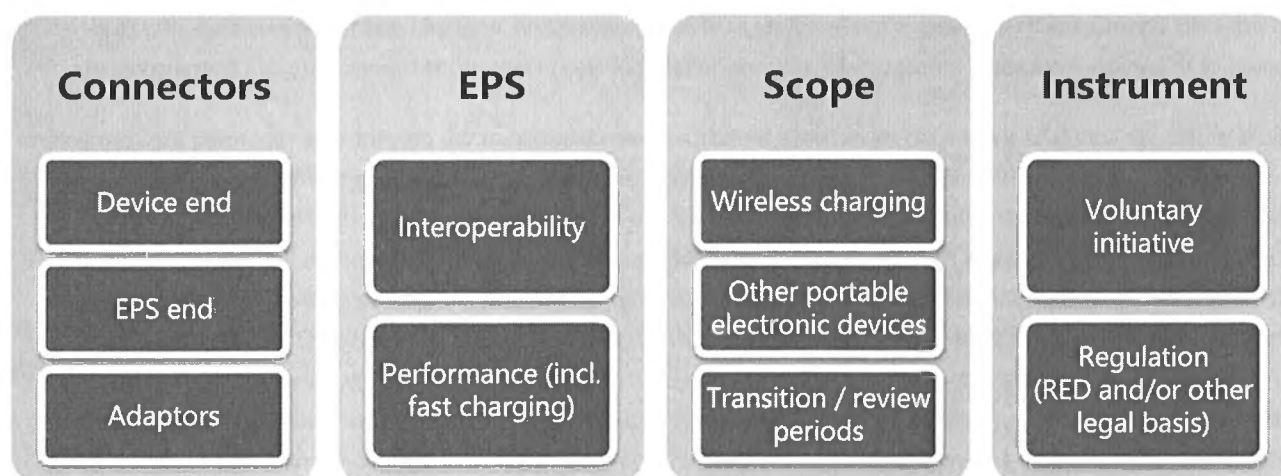
4 Policy options to be assessed

This section presents our current thinking, based on the trends, issues and problems outlined in the previous sections, regarding the policy options to be assessed as part of this study. It briefly discusses the various technical and legal elements that need to be considered and, following from this, provides a short-list of options we suggest to assess in-depth as part of the next phase of the IA study.

4.1 Elements for consideration

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), and although the connectors on the device end tend to receive the most attention from stakeholders when discussing a possible harmonisation initiative, 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 propose to discard the element in question from the in-depth assessment, and outline our reasoning behind this.

Figure 14: 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 3.1): 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 propose to 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 in their mobile phones are obliged to include an adaptor in the box. There are two technical variations of this option:
 - Manufacturers could either be obliged to include a cable with a USB Type-C connector and an adaptor that allows this cable to work with a proprietary interface (e.g. Lightning), or
 - Manufacturers could be allowed to continue to provide cables with a proprietary connector, but be obliged to include an adaptor that allows this to work with a USB Type-C interface.
- **Adaptors available on the market**: Manufacturers who wish to continue to use proprietary connectors have to make an adaptor available on the market (but not be obliged to include this in the box with the mobile phone).
NB: It is unclear to us at the present time whether this is implicitly included within the scope of the proposed 2018 MoU. The text of the 2018 MoU makes no explicit mention of adaptors. Apple has previously argued that the cables themselves should be considered as the adaptors.

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 propose not to 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.

As noted previously (see section 3.5), 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 external power supplies 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 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).

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 ampere) 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 - 5 watts (W), modern fast charging technologies boost these figures 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 also provide the performance consumers increasingly come to expect, a future common EPS could therefore include minimum specifications in terms of power, current and/or voltage.

- **Common standard to guarantee the interoperability of EPS:** This would entail a (voluntary or compulsory) commitment to the IEC 62680-1-2 and IEC 63002 standards. It will need to be further investigated whether the development of an additional standard specifically for a common EPS based on current USB technologies would be required / add value.
- **Minimum power requirements to facilitate adequate charging performance:** The exact thresholds would have to be defined carefully. Indicatively, they should guarantee the provision of at least 15W of power (in line with current fast charging technologies).

It should be noted that the exact technical requirements of both of these options, their feasibility and enforceability, and any other potential adverse implications in practice, will still need to be investigated further during the remainder of this study.³³

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, as already anticipated in our inception report, **we propose not to 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 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, the ToR clarify that the study shall provide 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 will 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 preliminary 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 will therefore be excluded from the scope of the IA.³⁴

³³ It is also worth noting that the 2009 MoU introduced the concept of the "preferred charging rate". It was defined as charging a battery from 10% capacity to 90% capacity within a maximum of 6 hours. It may be worth exploring whether, instead of or in addition to defining minimum power requirements, a new initiative could include reference to an updated preferred charging rate.

³⁴ 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.

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 propose to provide a clear assumption regarding the entry into force date we will use for the purpose of the impact analysis. It can then be inferred (and made explicit where particularly relevant) how a longer or shorter transition period would affect the results.

Indicatively, **we propose to use 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.

Instrument

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 propose to 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 propose to 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 will 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.

4.2 Summary of proposed policy options

Following on from the considerations put forward above, we propose to take the following approach to the policy options the IA study will address in depth:

- Assess six specific policy options – four 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 will consider the cumulative impacts of harmonising both the device-end connectors and the EPS.
- For each of the six options, we will also provide an account of:
 - the main impacts that extending its scope to other portable electronic devices would have, and

- o 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.

This approach is illustrated in Table 6 below. It would need to be validated by the Commission before proceeding with the IA on this basis.

Table 6: Summary of proposed policy options

	Connectors at the device end				EPS	
Policy options for mobile phone chargers	1. Baseline (2018 MoU: USB Type-C or proprietary)	2. USB Type-C only	3. USB Type-C or proprietary, plus compulsory adaptors in the box	4. USB Type-C or proprietary, plus adaptors available on the market*	5. Common standard to guarantee the interoperability of EPS	6. Minimum power requirements to facilitate adequate charging performance
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				

* To be clarified whether option 4 is already included within the scope of option 1.

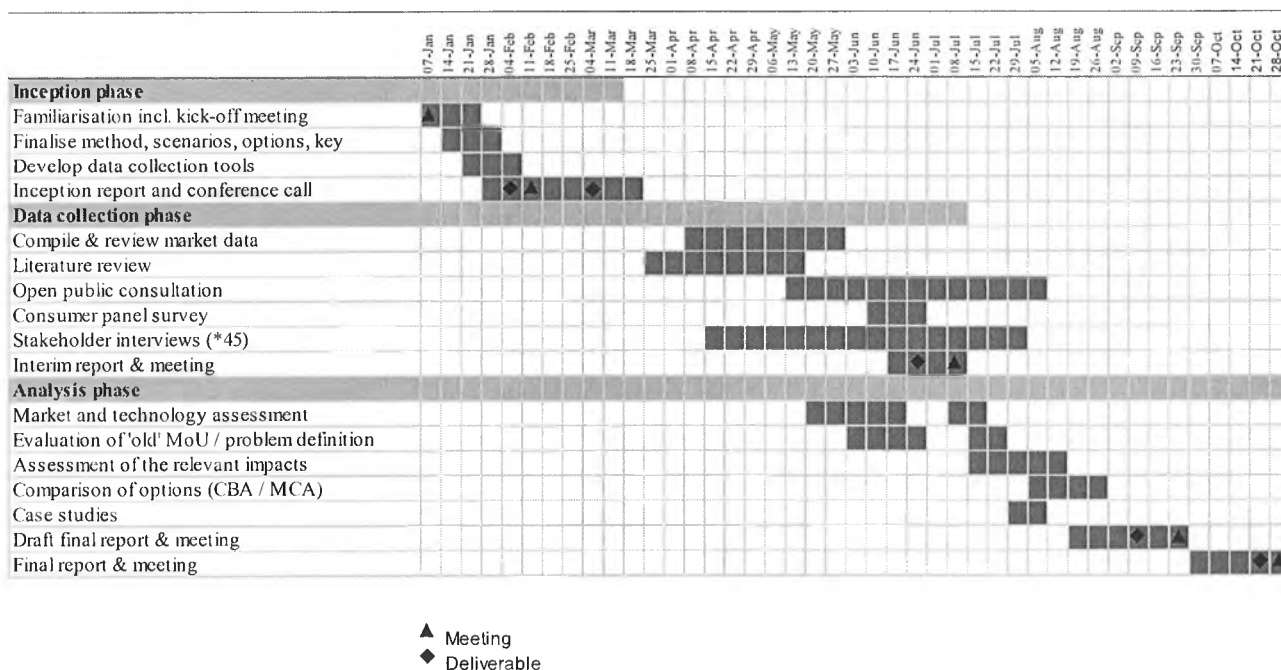
5 Next steps

As summarised in this report, in spite of the delays experienced with the public consultation and consumer panel survey, the data collection phase is well under way. In line with the revised work plan agreed by DG GOW via email exchange in early June, and reflected in the updated timetable below, the submission of the draft final report is now foreseen for 13 September, which should allow for the study to be finalised by the end of October 2019.

The key tasks to be completed before then are:

- Finalisation of the stakeholder interview programme
- Finalisation of the public consultation (which will remain open until 6 August)
- Refine the retrospective analysis (problem definition and baseline scenario)
- Agreement on and fine-tuning of the policy options for the prospective analysis
- Analysis and comparison of the likely impacts of these options
- Final reporting

Figure 15: Updated timetable for the study



We look forward to discussing the content of this report and the next steps with the Commission Steering Group during the meeting scheduled on 9 July 2019. We are particularly keen on feedback and input regarding the policy options we propose to form the basis for the prospective analysis (as per chapter 4 of this report).

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