Ref. Ares(2019)6407424 - 16/10/2019

March 2019

Impact Assessment Study on Common Chargers of Portable Devices

Inception 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 Allliance.
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 inception report is the first deliverable submitted to the European Commission by Ipsos MORI, Trinomics and Fraunhofer FOKUS on behalf of a consortium led by Economisti Associati, in the context of the Impact Assessment on the Common Chargers of Portable Devices. The main purpose of this report is to describe key elements of the proposed methodology we intend to use for the study, which has been refined and operationalised based on the familiarisation, scoping and structuring work we have undertaken over the course of the last month.

The first draft version of this report was submitted on 8 February 2019. The current version was revised to address comments provided by the Commission in writing and during a conference call held on 15 February 2019.

The inception phase of the project started with a **kick-off meeting** in Brussels on 7 January 2019, where DG GROW provided an initial feedback to the proposal submitted by the Consortium and key milestones for the project were agreed. Since the signature of the contract, the study team has carried out an **initial literature review** in three main fields: (a) statistics, market data and studies on chargers and mobile phones; (b) literature to refine the methodology to assess economic and environmental impacts; and (c) EU policy documents and legislation. More information on the initial evidence conducted is included in the Annexes. The study team has also conducted a series of **familiarisation interviews** with DG GROW staff, a consumer association (BEUC), an industry association (Digital Europe), and an environmental organisation (ECOS).

In line with the Terms of Reference, we have drafted a concise inception report that, rather than being an in-depth description of the entire methodology, presents the key elements that have been refined during the inception phase. We refer to the technical proposal, when needed, for completeness. The remainder of this report is structured as follows:

- Section 2 presents the **rationale and scope** of the present study, providing an initial "problem definition" for the impact assessment exercise, and further defining the scope of what we understand as "harmonisation of the charging solutions".
- Section 3 introduces a brief analysis of the **latest developments in the market**, including an overview of the USB standards, fast charging and wireless solutions. This analysis completes the rationale presented in Section 2 and helps to further define the scope of the study.
- Section 4 details **our approach to carry out the assignment** and includes our proposal to define the three **policy options** and key details of the **methodology to assess impacts** and **compare options**. It concludes by describing the **review of secondary data** we have carried out up to date and our proposed approach going forwards.
- Section 5 provides an updated **workplan**, as per the main milestones agreed during the kick-off meeting.

Finally, we have included six annexes: a draft questionnaire for the **Public Consultation**, the outline for the **questionnaire to the consumers' panel**, the list of stakeholders to be interviewed, examples of the **models to carry out the cost benefit analysis and the multicriteria analysis**, the key variables and assumptions to assess **environmental impacts**, and a detailed review of the **market data** available.

2 Rationale and scope of the present study

2.1 Purpose of the present assignment

The **purpose** of this assignment is to provide the European Commission with a full understanding of the likely impacts of harmonising charging solutions in three different policy options (the Voluntary Agreement signed in 2018, a new voluntary agreement, or a regulation), based on (at least) three technical scenarios that consider different cable assemblies. This assignment encompasses the following main tasks:

1. Problem definition: The first step of this exercise will be an analysis of the current magnitude of the problem, the problem drivers and how different stakeholders are affected. This task will be mainly based on a market analysis, a survey addressed to a consumer panel, and the update of the evaluation carried out in 2014. It will entail also developing hypotheses concerning how the charging solutions are likely to evolve in the future in the baseline scenario.

2. Identification of policy options: An initial list of options is presented in Section 4. The following steps will be narrowing down of such list into a more limited number of viable alternatives, if possible, and their development in greater detail.

3. Analysis of impacts: This task will be operationalised into four main steps, namely: (1) development of a theory of change; (2) the identification of the likely impacts; (3) the prioritisation of impacts, and (4) the assessment of the economic, social and environmental impacts associated with the various policy options. The study team has developed a stock model to quantify impacts, as outlined in our technical proposal.

4. Comparison of options: Once the expected impacts have been assessed, they are summarised and aggregated in order to allow for a comparison of the pros and cons of each policy option. This will be done via a CBA and, ultimately, using a multicriteria analysis.

2.2 Rationale and context

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

A previous study carried out by RPA in 2014[1] claimed that the **MoU signed in 2009**[2] was effective at harmonising charging solutions and improving consumer convenience. However, the study also recognised that **de-coupling had not been achieved yet**, with only a couple of companies in the UK and one mobile phone manufacturer (Motorola) offering the possibility to consumers to buy a phone without the charger, hence limiting the expected benefits on the environment.

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

[2] 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.

Despite the **adoption of USB micro-B** by most phone manufacturers, including MoU signatories and non-signatories, some major manufacturers were still using and developing **proprietary solutions** while the MoU was active. Most significantly, when it was signed in 2009, Apple products (iPhones, iPads and iPods) used a 30-pin dock connector, which is a proprietary solution, i.e. protected by patents. By signing the MoU, Apple voluntarily committed itself to work towards the harmonisation of a charging capability for the future. However, during this time the company did not shift towards an open harmonised solution. Instead, it launched in 2012 a renewed proprietary solution, the Lightning connector, which is nonetheless compliant with the MoU by virtue of the possibility of using an adaptor. In January 2019, the company has been reported to be testing "versions" of the 2019 iPhone line-up that use USB-C ports instead of the company's own Lightning connector.[3] If and when the company intends to shift to USB-C, however, is still an incognita.

Aside from Apple, **wider changes in the industry have taken place since 2014**: new entrants have entered the market; the USB type C is increasingly used in smartphones (mainly high-end phones) and other portable devices (e.g. Nintendo Switch); and wireless and fast charging solutions have emerged (for further details on these see section 3 below). In addition, the market share of some signatories of the previous MoU has declined significantly, and some have disappeared almost entirely, while a number of new players have appeared.

Ever since the MoU expired, the European Commission has been trying to foster the adoption of a new voluntary agreement, while the European Parliament and the Council also called in 2014 for renewed efforts to complete the harmonisation of chargers.[4] Four years later, in 2018, the industry proposed a **new MoU on the future common charging solution for smartphones**; this was signed by seven manufacturers in March 2018. During this period (2014-2018) the European Commission, led by DG GROW, held discussions with industry representatives (represented by Digital Europe) to achieve further harmonisation, taking into account the development of new USB Type C solutions. However, the first standard (Type-C Specification 1.0) had just been introduced in August 2014, while new specifications were being developed. The industry needed time to fully explore the potential and implication of the new solution, which reportedly explains (at least partly) the delay between the expiry of the first MoU (2014) and the adoption of the new one (2018).

As part of the 2018 MoU, the signatories[5] agree to "gradually transition to the new common charging solution for Smartphones based on USB Type-C", while noting that it has the ability to also be the "common charging interface for other types of portable electronic equipment".

The MoU is limited to wired charging solutions, and it considers the following cable assemblies to be compliant:

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

However, the Commission has **refused to endorse the new MoU**, stating that it does not fully align with the EU's harmonisation objectives, which seek to limit fragmentation of the charging solutions for mobile phones and similar devices. The new MoU continues to allow for proprietary solutions ("vendor-specific connect means"), which the

[3] https://www.theverge.com/2019/1/30/18204220/apple-new-iphone-testing-camera-three-rear-usb-c-port
[4] http://www.europarl.europa.eu/news/en/press-room/20140307IPR38122/meps-push-for-common-charger-for-all-mobile-phones
[5] Apple, Google, Lenovo, LG Electronics, Motorola Mobility, Samsung, and Sony Mobile

Commission no longer considers justified in view of the technical advantages provided by the introduction of the USB Type C. Therefore, according to the Commission, the new MoU would neither address the remaining fragmentation of the chargers, nor exclude the possibility of other new proprietary solutions emerging in the future.

The European Commission argues that further harmonisation would lead to increased consumer convenience, as they would be able to charge not only mobile phones but potentially also other portable devices with a common cable (and charger), as well as being offered the option of retaining existing chargers and purchasing mobile phones without chargers for a lower price. A harmonised solution, according to the Commission's initial analysis,[6] is also expected to reduce the number of counterfeit chargers in the market, reduce the import needs of chargers (as consumers could keep using their old chargers), and reduce electronic waste. At the same time, the Commission recognises that any further harmonisation should not limit innovation, i.e. the development and diffusion of new generations of chargers.

During familiarisation interviews, the European Commission also recognised that some business models may be barriers for harmonisation. For instance, proprietary charging solutions are in some cases a differentiation factor from competitors. In those cases, the proprietary solution may be part of the companies' consumer loyalty strategy to protect their source of revenue.

Industry representatives have expressed that regulation is not needed to ensure harmonisation, as the positive outcomes achieved by the previous MoU demonstrate. In turn, they argue it could **hamper innovation** in future charging solutions and in auxiliary sectors, such as the manufacture of other electronic devices. Industry representatives have also warned that a common charging solution for a broad range of products might be accompanied by an **increase in the volume of poor chargers** placed on the EU market, rather than a decrease as the Commission expects. The industry also seems concerned about the rapid shift towards USB Type C the Commission seems to suggest, instead of a gradual transition. USB-micro B is still the industry's preferred charging solution for most low-end phones, and industry argues that, in the short-term, a rapid shift may produce **more e-waste**, as cables with USB micro-B and external power supplies with sockets USB type A would become obsolete,, which in turn could **reduce consumer** convenience, given that transition costs would be passed on to consumers.[7]

To significantly reduce e-waste, it appears clear that de-coupling, among other factors, would need to happen (i.e. significant numbers of devices would need to be sold without a charger, allowing consumers to re-use chargers they already possess, and thereby reducing the number that are produced, bought and ultimately discarded). In familiarisation interviews conducted as part of this study, industry representatives have highlighted three major barriers:

- Reportedly, consumers expect to receive a charger when they buy a new phone. Like phones, chargers also have a limited life span, and new models are often more energy efficient.
- Some other portable devices, such as e-Readers, are often sold without an external power supply. Many consumers use their phones' external power supply to charge other portable devices, which reportedly increases the demand for phones to come with an "in-the-box chargers".
- Companies prefer to sell phones with a charger for safety reasons. Currently, phones are tested with the charger they bring "in-the-box". If consumers use chargers that do not meet standards, it may impact battery life and safety.

[6] European Commission Inception Impact Assessment. Ref. Ares (2018)6473169 - 15/12/2018

[7] See responses to the Impact Assessment Roadmap submitted by Mobile & Wireless Forum and Digital Europe

Consumer convenience and e-waste will also be determined by the number of chargers that consumers need on a daily basis, the possibility to use chargers with other devices (either small devices such as wearables or e-readers, or bigger devices such as laptops or videogames), and the life duration of chargers (including cables and EPS). In addition, consumer habits need to be explored to understand elements such as brand loyalty and likelihood to buy counterfeit chargers, which would impact on consumers' safety and the illicit market.

2.3 Scope and definitions

What is commonly called "**charging solutions**" consists of several elements: an external power supply (the AC power adapter, or charging block), a cable (except for wireless solutions), and the battery included in the phone. All these three elements are normally connected by via (USB or proprietary) sockets and plugs, although some external power supplies still have a built-in cable instead. Each of these elements are regulated by different pieces of EU legislation, as shown below:

Mobile telephones (and therefore the socket to connect them to the power supply) are regulated in the EU by the **Radio Equipment Directive** (2014/53/EU). Radio equipment is defined in Article 2.1(1) of the RED as "an electrical or electronic product, which intentionally emits and/or receives radio waves for the purpose of radio communication and/or radio determination, or an electrical or electronic product which must be completed with an accessory, such as antenna, so as to intentionally emit and/or receive radio waves for the purpose of radio communication and/or radio determination". Cabling and wiring are not covered by the RED because they fall out of the scope of the definition of radio equipment. Article 3(3)(a) stipulates that "radio equipment interworks with accessories, in particular with common chargers" as an "essential requirement". Article 10 stipulates that, when placing their radio equipment on the market, "manufacturers shall ensure that it has been designed and manufactured in accordance with the essential requirements set out in Article 3." Recital 12 further specifies that interoperability between radio equipment and accessories such as chargers "simplifies the use of radio equipment and reduces unnecessary waste and costs", and holds that a "renewed effort to develop a common charger for particular categories or classes of radio equipment is necessary", and in particular, that "mobile phones that are made available on the market should be compatible with a common charger."

The **Low Voltage Directive (LVD)** (2014/35/EU) covers health and safety risks on electrical equipment operating with an input or output voltage of between 50 and 1,000 V for alternating current and between 75 and 1,500 V for continuous current.[8] It applies to cables and power supply units.[9] Consumer goods with a voltage below 50 V for alternating current are covered by the General Product Safety Directive (2001/95/EC). The LVD is a "total harmonised safety Directive" in the sense that it covers all safety aspects of electrical equipment, not just the electrical risks.

The **Ecodesign Directive** (2005/32/EC) could also be relevant. Its implementing Regulation (EC) No. 278/2009 sets ecodesign requirements regarding the energy efficiency and no-load consumption of external power supplies (including phone chargers).

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[8] Voltage ratings refer to the voltage of the electrical input or output, not to voltages that may appear inside the equipment.

[9] Annex VII of the LVD Guidelines provides a number of examples of products that are within the scope of the LVD. It includes cables, cord sets and interconnection cord sets (plug + cable + cord set), multiple travel adaptors with supply (e.g. charger for mobile phones or music player), as well as product with integrated plug and/or outlets. 230V for domestic use (e.g. charger for mobile phones, night lights)

Hence, different regulations cover the two main components of the "charger", which introduces an element of legal complexity. In addition, should it be determined that neither of the Directives introduced above provides a sufficient legal basis for the harmonisation of charging solutions, the EC is considering as an alternative the use of the ordinary procedure via adopting a new legislation in accordance with Article 114 of the Treaty on the Functioning of the European Union (TFEU), which allows for the adoption of "measures for the approximation of the provisions laid down by law, regulation or administrative action in Member States which have as their object the establishment and functioning of the internal market".

The remit of the RED, the LVD and the Ecodesign Directive has implications for the scope of our study. We understand that via adopting measures under the RED, it would be possible to define the type of socket connecting the phone to the cable, but not to regulate the other end of the cable or the external power supply. Adopting measures via the LVD would have the opposite implications. This, in turn, also affects the extent to which harmonisation would be extended to fast charging and wireless solutions and to other portable devices. This study will have to be mindful of this issue. However, **the main purpose of this IA study is not to provide a comprehensive legal analysis, but to explore the extent to which different technical solutions have the potential to meet the Commission's main objectives**, in particular: (a) improve consumer convenience; (b) reduce e-waste; (c) and avoid dis-incentivising innovation.

In light of this, **the scope of this study** includes the following main physical elements[10]:

- The cable linking the phone with the external power supply, including both ends of the cable;
- The External Power Supply (EPS), including wireless and fast charging power supplies.

It is also fundamental to define the term "**harmonisation**" to further delimit the scope of the study. In standards, harmonisation is the process of minimising redundant or conflicting standards which may have evolved independently.[11] We understand harmonisation in the context of charging solutions encompasses three main elements: (1) interoperability, (2) safety, and (3) performance. The previous MoU covered all these three elements, although in the case of performance it was relatively lax: "The signatories undertake (...) to ensure their Mobile Phones are capable of being charged at the Preferred Charging Rate by any EPS meeting the requirements of a Common EPS." The Preferred Charging Rate was defined in the MoU as "charging a battery from 10% capacity to 90% capacity within a maximum of 6 hours".

Our study will follow the above criteria to define harmonisation, with the main focus on the interoperability element, the rationale being that the safety element is covered by the LVD (although we will analyse the impact on safety), and that most phones are nowadays compliant with the Preferred Charging Rate.

Finally, it is important to clarify the study's coverage in terms of **devices**. 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, the study, including the definition of policy options, will focus on charging solutions for mobile telephones. However, as part of the assessment of the impacts of each option, we will explore the extent to which it could affect the market for other devices, and provide an indication of the likely *indirect* impacts on these.

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[10] See p. 5 of the ToR

[11] https://en.wikipedia.org/wiki/Harmonization_(standards)

3 Developments since last MoU

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 a brief overview of a number of key developments in the areas of USB standards, fast charging, and wireless charging; as well as a summary of the interoperability of different technologies, and data on the market share of the main mobile phone manufacturers (as a first approximation to the prevalence of different charging technologies).

3.1 USB standards and specifications

USB (Universal Serial Bus) has kept pace with technology and the standards has been updated successively, from USB 1.1, USB 2.0, USB 3 and then USB 3.1 (officially launched in July 2013). Each successive USB standard has added more to the technology, improving and refining the performance. In practice, this means greater capacity to transfer not only power, but also data at a faster speed. The table below shows the performance of the different standards.

Table 3.1: USB charging standards

Standard	Voltage	Current	Max Power	Data transfer	Types of connectors
USB 1.1	5V	0.5A	2.5W	12 Mbps	Type A, Type B
USB 2.0 revised	5V	0.5A	2.5W	480 Mbps	Type A, Type B, Mini A, Mini B, Mini AB, Micro A, Micro B, Micro AB
USB 3.0	5V	0.5A/0.9A	4.5W	5 Gbps	Type A SuperSpeed, Type B SuperSpeed, Micro-B SuperSpeed (different shape to Micro-B)
USB 3.1	5-20V	0.5A/0.9A/1.5A/3A/5A	100W	10 Gbps	Type A SuperSpeed, Type B SuperSpeed, Micro-B SuperSpeed, Type-C
USB 3.2	5-20V	0.5A/0.9A/1.5A/3A/5A	100W	20 Gbps	Type A SuperSpeed, Type B SuperSpeed, Micro-B SuperSpeed, Type-C

When it comes to charging capacity, there are certain power-related USB specifications. The first specification was introduced in 2007 (USB Battery Charging 1.0). Since then, many specifications have been released, being the latest USB Power Delivery (multiple revisions and versions).

Table 3.2: Power-related USB specifications

Release name	Release date	Max. power
USB Battery Charging 1.0	2007-03-08	5 V, 1.5 A
USB Battery Charging 1.1	2009-04-15	
USB Battery Charging 1.2	2010-12-07	5 V, 5 A
USB Power Delivery revision 1.0 (version 1.0)	2012-07-05	20 V, 5 A
USB Power Delivery revision 1.0 (version 1.3)	2014-03-11	
USB Type-C 1.0	2014-08-11	5 V, 3 A
USB Power Delivery revision 2.0 (version 1.0)	2014-08-11	20 V, 5 A
USB Type-C 1.1	2015-04-03	5 V, 3 A
USB Power Delivery revision 2.0 (version 1.1)	2015-05-07	20 V, 5 A

Release name	Release date	Max. power
USB Power Delivery revision 2.0 (version 1.2)	2016-03-25	20 V, 5 A
USB Power Delivery revision 3.0 (version 1.1)	2017-01-12	20 V, 5 A
USB Power Delivery revision 2.0 (version 1.3)	2017-01-12	20 V, 5 A

The USB micro-B used in phones is only compatible with USB 2 (or USB 1). The USB Type C, however, is compatible with USB 2.0, USB 3.0 and USB 3.1, and it has also been developed to meet the needs of the USB Power Delivery (PD) specification.

On 8 January 2018 USB-IF announced "Certified USB Fast Charger" which will certify chargers that use the feature "Programmable Power Supply" (PPS) of the USB Power Delivery 3.0 specification.

3.2 Fast charging

Those charging solutions taking advantage of the USB 3.1 or USB PD standard are informally called "fast charging" solutions. There are several proprietary solutions offering fast charging (see list below), although most of them are either compatible with USB PD or with Quick Charge.[12] The latest two versions of Quick Charge (versions 4.0 and 4+) are compatible with USB PD.

In order to use fast charging, all the following elements are required: a device (and a battery) supporting fast charging; a USB Type C cable (although first versions of fast charging solutions support Micro-B); and a fast charging external power supply. In addition, the device and the external power supply need to be compatible to enjoy the fast charge. Below we present a non-exhaustive list of current fast charging solutions and their compatibility[13]:

- USB PD compatible solutions: Apple fast charging, MediaTek Pump Express, Huawei SuperCharge.
- Quick Charge compatible: Samsung Adaptive Fast Charging, Motorola TurboPower. In addition, any manufacturer is free to license Quick Charge's power controller technology (e.g. BQ, LG, Xiaomi, HTC, Sony Xperia, Nokia, Blackberry).
- Non-compatible: OnePlus Dash Charge and Oppo Vooc.

USB PD can deliver a much higher power output than Quick Charge. However, given that most smartphones do not need more than 18W charging, Qualcomm's Quick Charge has been widely adopted by many smartphone manufacturers. USB PD, as a standard, is more designed for larger devices like laptops and household appliances, and the fact that it can deliver higher power output does not necessarily translate into faster charging for smartphones. As an example, Quick Charge 4+ can charge a smartphone up to 50% in 15 minutes, whereas an iPhone, using PD, would need 30 minutes to reach this level.

Fast charging is in its early stages. Although USB PD and Quick Charge are not fully compatible, they are interoperable. This means that a device supporting Quick Charge can be charged with a USB PD external power supply, but at a normal speed (i.e. it would not offer the fast charge capacity). Following the definition applied in the MoU signed in 2009, hence,

[12] Quick Charge is a proprietary technology of Qualcomm.
[13] Interoperability and performance

these devices can be considered "harmonised", as they would charge a phone at the Preferred Charging Rate. It affects performance, nonetheless, and the definition applied in 2009 may not be suitable anymore, in which case it would affect the policy options (see Section 4). In addition, the fact that different fast charging solutions co-exist will have implications when assessing impacts, e.g. consumers who buy a phone supporting Quick Charge might want to buy a new compatible charger to enjoy the full speed.

3.3 Wireless charging

Inductive charging (also known as wireless charging or cordless charging) uses an electromagnetic field to transfer energy between two objects through electromagnetic induction. There are two main open standards: PMA and Qi. Most smartphones use the Qi technology, although some devices, including Samsung's, are also compatible with PMA. Wireless chargers only work with compatible devices. The iPhone X, iPhone 8, and most Android phones, including Huawei, allow wireless charging.

It can be deduced, from the table 4.3 below, that most phones sold in 2018 included the Qi wireless charging technology. As regards fast charging, however, phones seem to be equally divided between those supporting Quick Charge and those supporting USB PD.

Table 3.3: Cables and charging solutions used by the main vendors in the EU in 2018

Brand	Phone socket type	Fast charging	Wireless
Samsung	USB-C	Depending on the device, Samsung Adaptive Fast Charging (compatible with Quick Charge) or Qualcomm Quick Charge	Qi
Apple	Lightning to USB-C	Apple fast charging (USB PD compatible)	Qi
Huawei	USB-C	Huawei SuperCharge (USB PD compatible)	Qi
LG	USB-C	Qualcomm Quick Charge	Qi
Xiaomi	USB-C	Qualcomm Quick Charge	Qi

Wireless charging is a very incipient technology which, at the moment, does not offer great advantages over wired charging (wireless is slower and the phone cannot be moved around) and all main operators are using Qi as a standard. While wireless will not have major implications for the policy options, the study will aim to explore the likelihood that wireless charging could eventually supplant wired charging entirely, in which case the benefits of harmonising the latter could be short-lived.

3.4 Interoperability of different solutions

As explained above, there are currently several charging solutions in the market combining different EPS and cables. The table below includes a summary of the main solutions with a non-exhaustive list of the devices they can charge. (NB: By 'interoperability', in this context we mean the ability of the solutions in the first two columns to charge the devices in the third and fourth columns, without any restrictions, i.e. without requiring the use of an adapter or other accessories.)

Table 3.4: Interoperability of main charging solutions

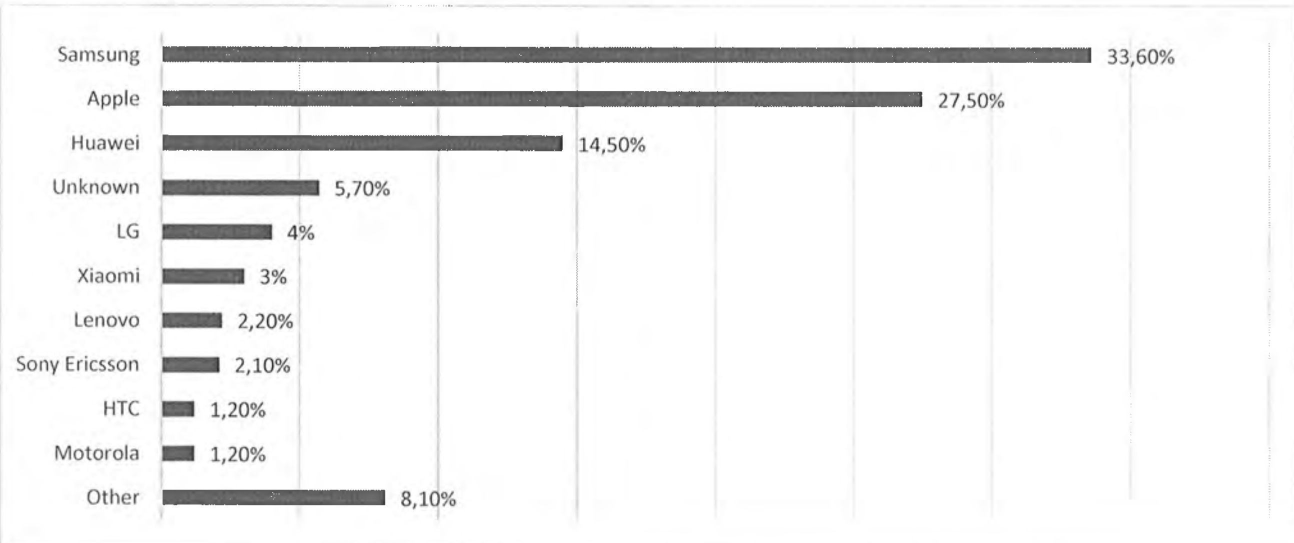
EPS	Cable	Interoperability with phones	Interoperability with other devices
Standard charger with USB A socket	USB A – USB micro B	Interoperable with "old phones" and low-end phones, except Apple EPS alone Interoperable with phones using different cables, at a normal charging rate (i.e. phones fast charging compatible could not take advantage of this feature).	Interoperable with small devices (e-readers, wearables). EPS alone interoperable with other devices using USB A and any other solution at the device end (e.g. cameras using mini USB)
	USB A - Lightening	Not interoperable with any phones other than Apple	Only interoperable with Apple devices (except older devices using 30-pin connector)
All in one charger	N/A – USB micro B	Interoperable with "old phones" and low-end phones, except Apple.	Interoperable with small devices (e-readers, wearables).
Fast charger USB PD compatible with USB A socket	USB A – USB C	Interoperable with phones USB PD compatible (e.g. high-end Huawei phones), except Apple Interoperable with any other phone with a USB C socket, at a reduced performance (without taking advantage of fast charge). EPS alone interoperable with old phones with USB A – USB micro B cables, at a lower performance	Interoperable with Nintendo Switch, some laptops and some cameras (e.g. GoPro). EPS alone interoperable with other devices using USB A and any other solution at the device end (e.g. cameras using mini USB)
Fast charger USB PD compatible with USB C socket	USB C – USB C	Interoperable with phones USB PD compatible (e.g. high-end Huawei phones) EPS alone interoperable with Apple phones (it needs an additional cable USB C – Lightening). Interoperable with any other phone with a USB C socket, at a reduced performance (without taking advantage of fast charge).	Interoperable with Nintendo Switch, some laptops and some cameras (e.g. GoPro).
Quick Charge EPS with USB A socket (Qualcomm's proprietary solution)	USB A – USB C	Interoperable with phones Quick Charge compatible (e.g. high-end Samsung, LG, Xiaomi) Interoperable with any other phone with a USB C socket, at a reduced performance (without taking advantage of fast charge). EPS alone interoperable with old phones with USB A – USB micro B cables, at a lower performance	Interoperable with Nintendo Switch, some laptops and some cameras (e.g. GoPro). EPS alone interoperable with other devices using USB A and any other solution at the device end (e.g. cameras using mini USB)
Quick Charge EPS with USB C socket	USB C – USB C	Interoperable with phones Quick Charge compatible (e.g. high-end Samsung, LG,	Interoperable with small devices using USB C at the device end (e.g.

EPS	Cable	Interoperability with phones	Interoperability with other devices
(Qualcomm's proprietary solution)		Xiaomi) Interoperable with any other phone with a USB C socket, at a reduced performance (without taking advantage of fast charge).	GoPro).
Fast charger using proprietary solution (other than Quick Charge)	There are several proprietary solutions, each with different specifications. For instance, Dash Charge works only with OnePlus phones and compatible wall adapters and car chargers. OnePlus' fast charging standard doesn't work with off-the-shelf USB cables — Dash Charge cables are slightly thicker to accommodate the extra voltage. Every OnePlus smartphone comes with a Dash Charge-compatible wall adapter and charging cord.		

3.5 EU mobile phone market shares

The approximate prevalence of the main charging solutions in the EU market can be estimated by looking at the market share of the different vendors. As figure 3.1 shows, the market was dominated by just three manufacturers (Samsung, Apple and Huawei), cumulatively accounting for 76% of the market share. Comparing these market shares with the signatories of the 2018 MoU shows that the 7 manufacturers account for around 70% of the current EU market (by value). The two major manufacturers that are not (yet) party to the 2018 MoU are Huawei and Xiaomi.

Figure 3.1: Mobile vendor market share in Europe in 2018



Source: StatCounter (http://gs.statcounter.com/vendor-market-share/mobile/europe/#monthly-201712-201901-bar)

It should be noted, however, that the market share is based on sales values (in EUR), and therefore can differ substantially from the number of phones sold, especially considering that Apple phones are, in general, more expensive than phones produced by manufacturers at the lower end of the scale. During the next phase of the study, we will undertake a more comprehensive analysis of data on mobile phones sales, as well as stand-alone charger sales, to provide an estimate of the stock of chargers currently in use that is as accurate as possible.

4 Key elements of our approach

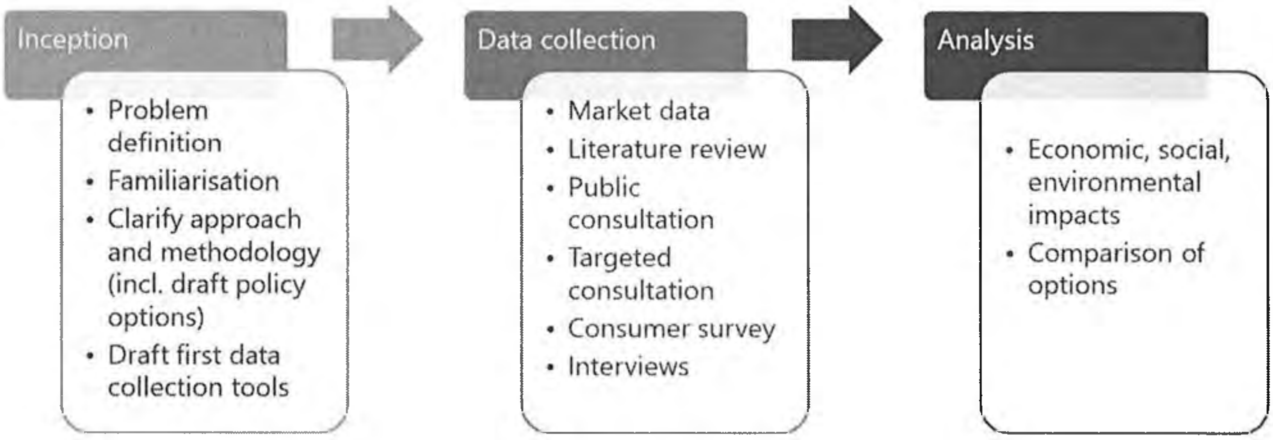
This section of the report outlines key elements of our approach. In the interest of brevity[14] and readability, the section does not aim to repeat the approach or provide a detailed description of all of the methods outlined in our technical proposal, but rather highlight the main elements requiring review and buy in from the steering group.

4.1 Overall approach

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

The main tasks of the methodology are structured across an inception phase, a data collection phase and an analytical phase. They include primary research targeting the stakeholders and interested parties at large (via a public consultation), consumers and industry (via targeted consultation methods), as well as secondary research reviewing existing literature, policy and legal documents as well as existing market data focussing on mobile phones and standalone chargers.

Figure 4.1: Overall study approach



The remainder of this section provides information on key elements of the approach to the data collection and analysis, as refined in light of the familiarisation activities and challenges identified during the inception phase, along the lines of the next main steps of the IA process:

- Defining the problem: Informed by our inception activities, in particular the elements summarised in sections 2 and 3 abobve, we have provided a summary of the current state of play with regard to harmonisation of mobile phone chargers and, based on this, drafted a preliminary definition of the problem that the initative is intended to address.

- Defining policy options: We present our proposals for how to conceptualise, define and structure the main policy options to be assessed as part of the study.

[14] The Terms of Reference for the study ask for an inception report of "around 10 pages".

- Assessing impacts: We present the screening of the different economic, social and environmental impacts the study is assess, followed by a number of specific methodoliogical considerations related to the main tools we intend to use to collect and analyse data for the most significant impacts.

- Comparing options: We provide a summary overview of how we intend to aggregate the quantitative and qualitative evidence on the likely impacts into a comprehensive framework for comparing the options.

4.2 Problem definition

What follows is a preliminary, concise summary of the main problems the initiative is intended to address, based on the information currently at our disposal. This builds on (rather than repeats) the main technological and market developments discussed earlier in this report, and is intended to provide a starting point for the ensuing steps of the IA. As the study progresses, and we collect and analyse further evidence of the significance of the problems, and of their exact drivers and consequences, the problem definition will continue to evolve.

The current status

Prior to the adoption of the 2009 MoU, mobile telephones were typically only compatible with specific chargers. From 2010 onwards, the number of different chargers on the market declined substantially,[15] with most manufacturers adopting charging solutions based on the common technical standard and Micro-USB connectors on the phone side (and those who continued to use proprietary connectors, namely Apple, offering adaptors).

However, following the expiration of the MoU in 2014, and the Commission's decision not to endorse the proposed new MoU tabled by the mobile phone industry in 2018, there is currently no set of common rules[16] governing the interoperability of mobile phone chargers in the EU. In broad terms, and to the best of our knowledge at the time of writing, the current market situation can be summarised as follows:

- At present, all mobile phone charging solutions on the market consist of **two separate parts** – an external power supply (EPS or charging block) and a cable to connect the EPS to the phone – which are detachable.[17]

- The vast majority of **cables to connect** the mobile phone with the EPS that are currently in use are terminated with a USB Type A plug on the EPS end (although some of the newest models are beginning to use USB Type C). On the phone end, there are currently three main types of solutions: USB Micro B (the 'default' solution under the 2009 MoU), USB Type C (which appears to be replacing the former as the connector of choice of most manufacturers), and proprietary solutions (incl. Apple Lightning).

- All **external power supply (EPS)** units contain a USB Type A and/or Type C socket and are interoperable, meaning that, with the correct cable, they can be used to charge any mobile phone. However, the emergence of fast

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[15] RPA 2014, p. iii

[16] Other than the USB industry standards that establishes specifications for cables, connectors and protocols for connection, communication and power supply; and the EPS standard developed following the 2009 MoU (published in December 2010 as EN 62684:2010 "Interoperability specifications of common EPS for use with data-enabled mobile telephones" by CENELEC and in January 2011 by the IEC as IEC 62684:2011)

[17] Some older chargers with no detachable cable are likely to still be in use, but, to the best of our knowledge, such chargers are legacy products that are no longer being sold with or marketed for use with any current generation mobile phones.

charging technology can give rise to performance issues: typically, the phone will only charge at the full (fast) rate if the 'right' combination of EPS, cable and phone is used.

According to industry sources, the future is likely to bring further convergence towards USB Type C connectors (and the signatories of the proposed 2018 MoU agreed to "gradually transition to the new common charging solution for Smartphones based on USB Type-C"). However, without a voluntary commitment or regulatory solution in force, there remains a risk of further market fragmentation due to the emergence / proliferation of proprietary solutions.

Problems

As summarised above, the degree of interoperability between current charging solutions for mobile phones appears relatively high (certainly when compared with the situation in 2009). However, the continued lack of a truly "common" charger, and the potential for further fragmentation in the future, could give rise to a number of problems. The study will have to verify and substantiate the extent to which these problems exist, as well as their significance, but preliminarily, we can point to the following main aspects:

- Consumer inconvenience: A common charger would provide consumers with maximum flexibility to charge mobile phones (and potentially also other portable electronic devices requiring similar charging capacity). At present this flexibility is limited by the different charging solutions in use, which can cause inconvenience for one or more of the following reasons:
  - The continued existence of different connectors can make it more difficult for consumers to charge their phones using chargers other than the one supplied with the phone, e.g. when away from home. It also obliges many consumers or households who use more than one phone to own and use a number of different chargers (or at least cables), which can be inconvenient insofar as it causes confusion and clutter.
  - The emergence of fast charging solutions means that, despite the *interoperability* of different manufacturers' EPS, their *performance* is suboptimal when used with phones that rely on a non-compatible fast charging solution. This reduces the flexibility of consumers, and can also lead to inconvenience of the kind described above.
- Consumer cost: Nearly all mobile phones continue to be sold with their own 'in the box' charger (cable and EPS), which comes at a financial cost to consumers since the cost of the charger is passed on to them by manufacturers. If a fully harmonised charging solution existed, this cost could be reduced via the 'de-coupling' of phones and chargers, giving consumers the option of using an existing charger rather than being obliged to purchase and pay for a new one with each phone (although the extent to which consumers would be prepared to make use of this option in return for a lower price will need to be investigated further).
- Negative environmental impacts: The production of each charger (EPS as well as cable) requires raw materials; their production and transport also generates CO_2 emissions. When chargers are no longer used, they generate electronic waste. The higher the number of chargers produced, used, and eventually discarded, the more significant these impacts are. An initiative that leads to a reduction in the number of chargers (via de-coupling, and/or a reduced need for consumers to purchase stand-alone chargers) would therefore be likely to generate environmental benefits.

- **Safety concerns:** The 2014 RPA study found that, based on a number sources, *many* counterfeit chargers on the market and *some* non-OEM chargers, often unbranded, do not comply with the applicable standards.[18] This can pose safety risks for consumers, especially in the case of counterfeit chargers.[19] Since it seems that relatively expensive proprietary charging solutions (in particular Apple's) are most often targeted by counterfeiters, further harmonisation of charging solutions could potentially reduce the market for counterfeit chargers, and thereby reduce safety risks for users.

4.3 Defining policy options

During the inception phase, we have reviewed the evidence collected from our desk review and scoping interviews. Based on this, we have developed a set of draft policy options. Based on our understanding of the Commission's requirements, the study purpose, and the key technological and other developments (as summarised previously), we believe a small number of technical sub-options addressing different elements of charging solutions, and representing different levels of ambition, would be most sensible to define for all options apart from baseline (no action). Indicatively, we therefore propose for the study to assess the following set of options and sub-options:

- **Option 1 - Baseline** – this option would entail an unchanged situation to the current state of play. The voluntary agreement proposed by industry in early 2018 would not undergo any changes, and the European Commission would not take any regulatory action. Assuming that industry (or rather, the signatories) would comply with the MoU despite the lack of Commission endorsement, new smartphone models sold on the EU market by the MoU's signatories (currently representing around 70% of the market) would thus use a USB Type-C connector or cable assembly, including: (1) a cable assembly that is terminated on both ends with a USB Type-C plug; (2) a cable assembly that is terminated on one end with a USB Type-C plug and has a vendor-specific connect means (hardwired/captive or custom detachable) on the opposite end; or (3) a cable assembly that sources power to a USB Type-C connector from a USB Type-A connector. Smartphones complying with the initial MoU from 2009 would also still be sold.

- **Option 2 - Extended voluntary action by industry** – this option would entail changes to the voluntary agreement currently proposed by industry, and the European Commission subsequently formally endorsing the voluntary agreement. Two sub-options seem to be possible here:

  - **Suboption 2a – Rule out proprietary connectors**: MoU amended to clarify that vendor-specific (proprietary) connectors are not considered compliant.

  - **Suboption 2b – Extend scope to other aspects**: MoU amended to clarify that only a cable assembly that is terminated on both ends with a USB Type-C plug is compliant. Furthermore, this option would define standards for fast charging (e.g. by mandating that all charging solutions should be capable of charging a mobile phone battery from 10% to 90% within a maximum of 60 minutes).

[18] RPA (2014), p. 60

[19] A recent report by the UK's Electrical Safety First found that 98% of counterfeit and imitation Apple chargers tested failed the safety test, and that these chargers pose a "significant risk to the health and safety of users." URL: https://www.electricalsafetyfirst.org.uk/media/1119/counterfeit-and-imitation-apple-chargers.pdf

- Option 3 - Regulatory action – regulatory action by the European Commission can take many shapes and forms, and there is a multitude of technical and legal scenarios that are possible. In broad terms, reflecting the main components of charging solutions, we propose to frame the sub-options as follows:

    - Suboption 3a – Harmonise connectors: This regulatory initiative would mandate a standard connector to be USB Type-C (following a reasonable transition period during which other connectors would still be allowed), but would only cover the connection between mobile phones and the cable assembly. It would not mandate any other specification, for example the power supply unit or the opposite end of the cable assembly. The most likely legal basis would be the Radio Equipment Directive, and the most likely implementation of such an initiative would be through a delegated act.

    - Suboption 3b – Harmonise external power supply: This option would only address the external power supply (charging block), in order to ensure interoperability as well as harmonise performance specifications (which is especially important with a view to fast charging). The Low Voltage Directive could provide a legal basis for this (although it needs to be noted that it is primarily intended to deal with safety issues).

    - Suboption 3c – Comprehensive regulatory action: This option would entail regulatory action by the European Commission which mandates harmonisation of all elements of charging units (incl. the cable assembly as well as the power supply unit), mandating that the cable assembly have USB Type-C connectors at both ends, and the power supply be capable of guaranteeing a certain level of performance irrespectively of which phone is charged with it (for example, charging a mobile phone battery from 10% to 90% within a maximum of 60 minutes). The legal basis (or bases) for such far-reaching legislative action would still need to be clarified

The options listed above will need to be clarified and defined in further detail (including with regard to different technical scenarios, including those outlined in the Commission's inception IA), so as to provide a solid, concrete and realistic basis for the ensuing analysis. Doing so will require (1) further in-depth familiarisation with the most relevant technical and legal parameters; (2) an understanding of key stakeholder views and concerns (including the position of the industry with regard to the potential for an "improved" voluntary approach); (3) consultation and agreement with the Commission regarding the appropriate level of ambition, to ensure options are legally, technically and politically feasible, and fit for purpose.

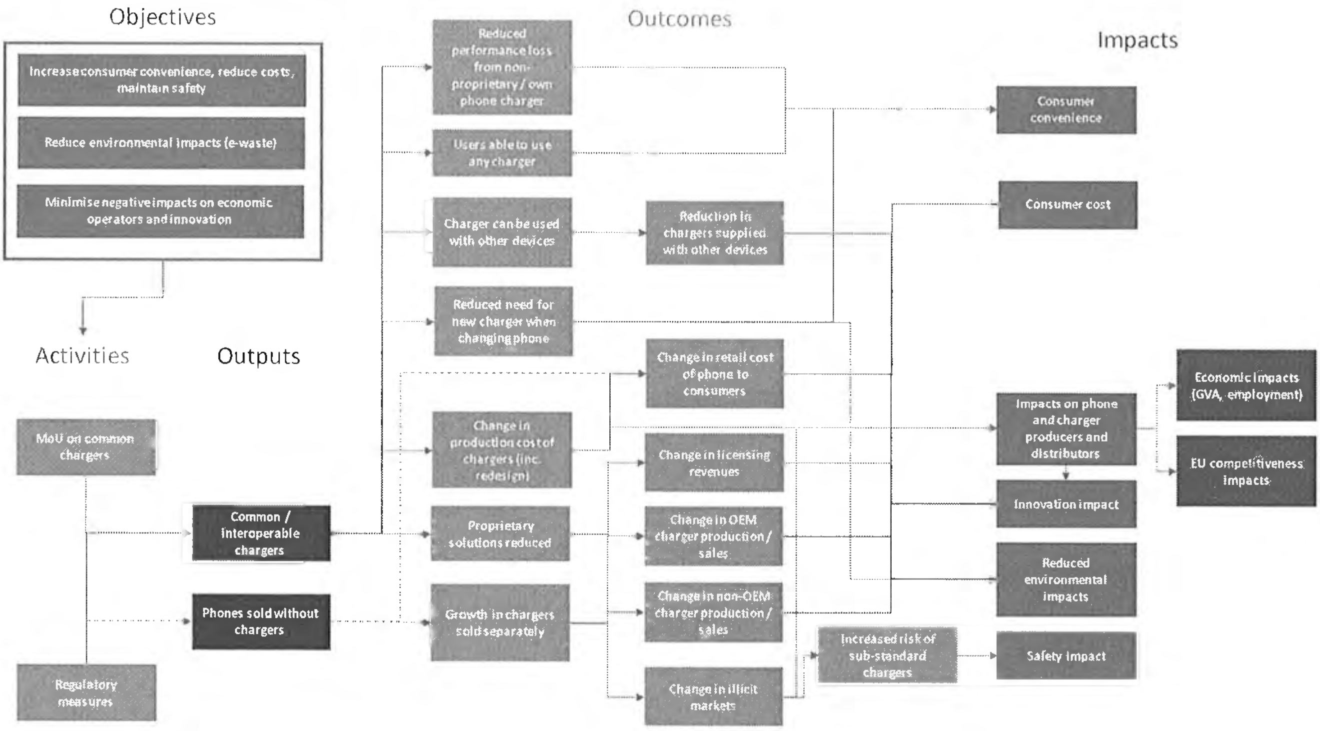
Scenarios could then be built around these sub-options to estimate the range of likely impacts, providing for a balance between analytical rigour and clarity on the one hand, and sufficient coverage of technical detail on the other. Additional technical considerations that may not be directly and explicitly addressed in the way these sub-options are defined could still be explored during the impact assessment stage, by analysing specifically how varying such parameters within the main options and sub-options would affect the likely impacts.

As noted above, we are aware that these "core" options will need to be further refined in their technical detail. At this stage, we would be grateful for any feedback regarding how we have framed and conceptualised the options, as well as suggestions for how they could be amended or further refined. Once the broad approach has been agreed with the Commission, the options are likely to continue to be refined throughout the study as further information and evidence becomes available. (as is usually the case due to the iterative nature of IA studies).

4.4 Assessing key impacts

The impacts to be assessed are based on the intervention logic, a first draft version of which was set out in the proposal. This highlights the key pathways to impact from any proposed interventions in the area of chargers. A further review of the intervention logic has led to modifications to both expand and streamline it, see Figure 4.2: This flags the key economic, social and environmental impacts and the main causal routes to these resulting from an intervention.

Figure 4.2: Draft intervention logic for the impact assessment



In respect of economic impacts, we include impacts on the macroeconomic environment (GVA, employment), competitiveness, innovation, administrative/regulatory burden and consumers. We propose to split the impacts per group of economic operator to the extent possible to address both SMEs and the impact on third countries/trade. Other economic impacts listed in the screening guidance[20] include energy independence, functioning of the internal market, public authorities (budgets), economic cohesion and impacts in developing countries. Having duly considered them, we believe that these impacts are not significant to the assessment in this study.

In respect of environmental impacts, we include four main impacts – impact on climate change (CO_2 emissions) and its international dimension, resources (raw materials consumption), waste generation and recycling (e-waste) and impact on sustainable consumption and production (SCP). The latter impact was not assessed in the RPA 2014 study. Other environmental impacts listed in the screening guidance include impacts on air, water, biodiversity, soil and land use, transport and the use of energy, and animal welfare. These impacts do not appear to be significant within the frame of this study and hence are not assessed. One impact that was screened was the potential for greater energy use from particular charging solutions due to differing efficiencies, a review indicates that this is not a specific issue for fast charging and that the control/switching chips may reduce energy waste of chargers. For wireless charging it is the case that charging efficiency is lower, but as the policy options and regulation do not intend to address this, still very small and rapidly developing area then this will not be addressed in detail unless specific new evidence or trends are identified.

On the basis of this we have carried out the screening of impacts to be assessed, these are presented in Table 4.1: below. The impacts in the table were selected on the basis of the Terms of Reference, our proposal, the Better Regulation guidance (Toolbox #19) and discussions at the kick-off meeting.

Table 4.1: Screening of impacts to be assessed

Impacts	Key impact pathways	Proposed approach	Proposed indicators
Consumer benefits	Consumer convenience/detriment and utility – from chargers (not) being interoperable and between different charging solutions	Assessing the cost of inconvenience to consumers will be a major part of the potential benefit of such an initiative. The approach will use the consumer survey to analyse consumer preference, and subsequently foregone utility in case of non-harmonisation	Quantitative indicator(s) of: • Consumer preference and (in)convenience / utility (based on conjoint analysis and other elements of consumer survey) • Consumer detriment from different performance of replacement chargers
	Consumer cost – of a charger, either as part of the phone or separately	Need to assess potential difference in charger cost under different options and the 'pass-through' of any cost increases to consumers. This will be a key cost, but also a potential double-counting with producer costs, will need to use a cost pass through assumption to separate the two. Necessary evidence will be provided through an analysis of retail data and interviews with key industry stakeholders, to be aggregated through stock model analysis	Quantitative indictor of: • EUR increase/decrease in aggregate cost to consumers – from mobile phones (due to charger) and separate chargers

[20] European Commission (2017): Better Regulation Toolbox, Tool #19: Identification / screening of impacts.

Impacts	Key impact pathways	Proposed approach	Proposed indicators

Impacts on economic operators (incl. SMEs)	Adjustment, compliance, transaction costs	These represent potentially major impacts on economic operators, resulting from:
		• Additional production costs compared to proprietary chargers
		• Foregone revenue from sales of proprietary chargers
		• Changes in the number of chargers sold – resulting in production cost savings if no charger supplied with phone and changes in revenues for standalone charger manufacturers
		This will require specific data on production cost of different charger types and respective sales data. Assumptions on decoupling will also be needed. These data and assumptions to be acquired through desk research and consultations with industry, although data on production costs might be difficult to collect. Fallback options will be based on retail prices of standalone chargers collected from major sales platform such as amazon, modified for estimated margins. When applied in stock model aggregated impacts can be quantified. Adjustments to industry cost will need to be made based on cost pass through to consumers.
			Quantitative indicators of:
			• EUR change in production costs (also saving in case of decoupling)
			• EUR change in revenues
			  o Will need to be split by industry segments
			  o Also per EU and non-EU industry

	Broader economic impacts (growth and employment)	Changes in costs and revenues will have consequent impacts on growth and employment. Through use of simple sector average ratios the direct effects on growth and employment can be estimated. The sector average ratios will be applied to the aggregated impacts estimated in the stock model Indirect or induced effects, i.e. the effects of these changes on the supply chain or the changes in income and spending in the wider economy, will not be estimated.	Quantitative indicators of:
			• EUR change in GVA expected
			• Change in employment
			  o Will need to be split by industry segments
			  o Also per EU and non-EU industry

	Regulatory burden / simplification	Is unclear if these will be a significant impact. We propose to assess qualitatively based on feedback from industry and public stakeholders (compliance bodies) in interviews.	Qualitative indicator: • Regulatory burden
Impacts on the environment	Raw materials consumption	The production of chargers requires raw materials. The number of chargers (including proprietary, non-interchangeable chargers) and the decoupling rates that are likely to be achieved will have an impact on the amount of raw materials generated and potentially saved (in case of decoupling). A starting point will be to replicate the analysis in the RPA 2014 study, which estimated raw materials saved as: *Raw materials saved (tonnes) = average weight of a charger (grams) * avoided sales due to decoupling (sales * decoupling rate) * % of non-recyclable content in a charger* The needed data to calculate this indicator will be collected from the literature (information on all the elements of the equation), industry consultations (data and information on the composition of a charger, sales) and the consumer survey (information on the number of chargers owned and used, by household and if any charger(s) was bought separately). The number of chargers and the decoupling rates will be estimated using our market data review, the consumer survey and subsequently the stock model proposed for this study.	Quantitative indicator of: • Tonnes of raw materials generated and saved (in case of decoupling) • Shares of different materials in a charger and the related total impact Qualitative indicator of: • Raw materials consumption impact of different charging solutions

Impacts	Key impact pathways	Proposed approach	Proposed indicators
		In addition to this, we will look at the material composition of the different chargers using lifecycle assessment (LCA) literature and inputs from our technology expert to provide an estimate of the specific generated and saved materials, such as e.g. plastics, metals, critical raw materials.	
	Electronic waste	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 decoupling rates that are likely to be achieved will have an impact on e-waste generation and potential savings. However, the relation between these two is not straightforward as the majority of unused chargers are not properly disposed of (i.e. recycled). A starting point will be to replicate the analysis in the RPA 2014 study, which estimated e-waste avoided due to decoupling as: *e-waste avoided (tonnes) = average weight of a charger (grams) * avoided sales due to decoupling (sales * decoupling rate) * % of non-recyclable content in a charger * % of chargers being recycled* This impact is calculated similarly as raw materials consumption. However, the main determinant of e-waste impact as the percentage of chargers that are actually being recycled. To collect this information, and information on what happens with old chargers, we will rely on the results of the consumer survey.	Quantitative indicator of: • Tonnes of e-waste generated and saved (in case of decoupling) • % and number of how old chargers are used (recycling, given away, unused, etc.)
	CO_2 emissions (climate)	The production and transport of chargers creates a climate change impact as materials are used and tonnes of weight need to be transported, resp. CO_2 savings can hence occur during manufacturing and transport phase. We will also start with the RPA 2014 study analysis, which estimated the climate change impact as: *CO_2 emissions avoided (tonnes CO_2 eq.) = avoided sales due to decoupling (sales * decoupling rate) * assumptions on CO_2 eq. avoided per charger* The evidence on CO_2 eq. per charger will be collected from LCA literature.	Quantitative indicator of: • Tonnes of CO_2 eq generated and saved (in case of decoupling) Qualitative indicator of: • Climate impact of different charging solutions
	Sustainable consumption and production (SCP)	The choice of a specific charger and/ or whether to contribute to the decoupling rate will have an impact on promoting or not SCP. This impact will be more relevant to the assessment of options in Task 2, where one can analyse whether a specific option will lead to more or less SCP, and to the promotion of environmentally friendly goods and services. This impact can be assessed qualitatively through interviews and surveys by introducing questions for technology experts and manufacturers on the degree to which a specific type of charger contributes to SCP.	Qualitative indicator of: • Impact on SCP and the promotion of environmental goods and services
Impact on innovation and	Innovation	Harmonisation could potentially stifle innovation and become quickly outdated if the agreed standard is not flexible/dynamic enough. This will be a major impact	Qualitative indicator: • Stakeholder views on extent of innovation

Impacts	Key impact pathways	Proposed approach	Proposed indicators
competitiveness		and talking point from industry perspective, where this is perceived as a crucial reason not to regulate. Chargers are a relatively small part of the cost of a phone, and that producers innovate much more on other features (screen, camera, apps), so actual impact may be less, but it is also the case that the current 'generation change' in chargers makes this an interesting and important moment for innovation. Will need to address this question qualitatively through survey and interviews with industry and other stakeholders.	impacts
	Competitiveness	Share of EU industry in the sector is relatively small, therefore EU-relevant competitiveness impacts are likely to be low. Impacts will need to be discussed with EU-based manufacturers and other firms in the sector through interview and rated qualitatively. It should be possible to provide outline estimates of size of market affected.	Qualitative indicator: • Impact on EU competitiveness
Impact on safety	Safety – risk of injury, damage	Primarily relating to the risks from illicit markets and low-quality, non-OEM chargers which may proliferate in high decoupling scenarios. Data from RAPEX and ICSMS can be used to inform assumptions of risks and changes in different policy scenarios. These will be bolstered by reflections on this issue from interviews with key stakeholders (industry, public inspection authorities, trade bodies).	Qualitative indicator: • Impact on safety Quantitative indicator • Number of incidents from RAPEX/ICSMS
Impact on illicit markets	Illegal market - size	Desk research into this issue (using customs information collected by the European Observatory on Infringements of Intellectual Property Rights) will attempt to quantify the current size of illicit markets and direction of trends. Stakeholder interviews will be used to explore further this issue to enable useful assumptions to be built into the stock model and impact analysis. As major impacts of this will be felt by other economic operators (e.g. intellectual property infringement and reduced sales leading to decreased revenue, possible reduced innovation investments) and as impacts on safety it may make more sense to integrate this impact as an assumption within these other impacts.	(possible sub-) indicator: • Size of illicit market

Building on the table above, in what follows we highlight a few key aspects of our methodology that are particularly important to assessing certain key types of impacts, and discuss some important methodological considerations and challenges as well as, where relevant, proposed amendments to the methods as originally proposed.

Impacts on consumers

The main method we propose to assess the impacts on consumers (in terms of consumer benefit or detriment of the current situation and the main policy options) is a panel survey of a sizeable, representative sample of EU consumers. A research panel is a group of previously recruited respondents who have agreed to take part in surveys and/or other research. Ipsos has been carrying out panel surveys since the 1970s, and has well-established online panels in most EU MS. For this survey, we will cover 10 MS (incl. five of the largest ones – Germany, France, Italy, Poland, and Spain; as well as the Czech Republic, Hungary, the Netherlands, Romania and Sweden[21]), and aim to collect 500 responses per country. This should be easily achievable given that the vast majority of panel members are mobile phone users, and is a sufficient sample size to extrapolate the results to the whole population. To maximise response rates, the questionnaire will be translated by Ipsos into the local languages of the ten selected MS.

The questionnaire design will have to satisfy a number of requirements. It will have to allow an estimation of the consumer detriment resulting from non-harmonised charging solutions, safety and performance-related problems, it will have to provide inputs on the number and characteristics of chargers in use (in particular standalone chargers), as well as on the nature of consumer use and lifetime of chargers, to feed into our planned stock model (see technical proposal for details). Furthermore, the technical proposal suggested to query respondents about their use of phone chargers to charge other devices, and the extent to which fast charging and wireless charging solutions as well as adapters are in use and have been purchased separately from standard phone chargers. Across these three main themes, the survey will have to provide a representative picture, to allow extrapolation onto the entire population of EU consumers as well as chargers in use across this consumer base.

It will be challenging to accommodate these elements into a questionnaire of 15 minutes and up to 25 closed survey questions. We therefore propose to modularise the questionnaire and prioritise elements of the questionnaire that will be crucial in informing a) our estimates of the current stock of chargers and the rate at which they are discarded (for which we will develop a stock model as described in our technical proposal), b) estimating the consumer detriment emerging from non-harmonisation and decoupling and c) understanding consumer preference of different charger attributes and types. An initial outline of the consumer survey questionnaire is provided for review in the Annexes of this report.

Impacts on economic operators

The analysis of the likely impacts on economic operators will have to rely heavily on information collected from industry representatives (incl. manufacturers of mobile phones, manufacturers of other portable electronic devices, manufacturers of chargers, and distributors). Our initial proposal was to consult these stakeholders via an online questionnaire and 15 in-depth interviews. However, research conducted during the scoping phase indicates that an online questionnaire is unlikely to be suitable:

- The 2014 RPA study achieved very low response rates from industry stakeholders (for example, only 5 out of the 31 mobile phone manufacturers contacted replied).

[21] We had originally planned to include all six large MS, but following a request from DG GROW, propose to replace the UK with the Czech Republic.

- Industry stakeholders may have legitimate concerns about data protection when it comes to answering online questionnaires, especially as regards information that may be commercially sensitive.

- Initial contacts stablished with industry representatives have suggested that in-depth interviews are a more suitable approach to engage industry stakeholders. Identifying the right person at each organisation to respond to the online questionnaire would be challenging, and initial contacts have stated their preference to carry out in-depth interviews instead.

- The number of industry stakeholders to be consulted per sub-group is rather limited, which reduces the efficiency of conducting an online survey/questionnaire.

- In our experience, and after further analysing the problem in question, we consider that an online survey will not elicit the depth and detail of responses that will be needed to answer the key study questions.

As a mitigation action, we suggest to no longer attempt an online survey of industry stakeholders, and instead increase the number of in-depth interviews with industry stakeholders from 15 to 30. Additional quantitative data from industry will be collected through a datasheet that will be shared with consultees in advance of each interview. This approach has proved to be successful in consultations of industry representatives carried out by the study team.[22] Ipsos has a secure system to send data files via email.

As requested by the European Commission, this approach will be re-assessed after the first round of interviews has taken place.

Impacts on the environment

As noted in the proposal, this study will take a fresh look at the evidence provided in the RPA 2014 study and update the relevant information and data needed to calculate and estimate the environmental impacts of the previous MoU, e.g. the sales of chargers, decoupling rates, recycling rate, etc.

In the prospective impact assessment, the focus will be on identifying the changes in environmental impacts across the different policy options identified. The main environmental impacts of the future initiative would relate to two key factors: (1) the additional number of chargers needed in total if proprietary, non-interchangeable charging methods proliferate; (2) the decoupling of new chargers from device sales if this could be achieved by the policy option in question. In other words, significant benefits would materialise if chargers were interchangeable and the number of unnecessary chargers sold were to decline, which is unlikely to occur while mobile phones and other devices are routinely sold with a charger or if competing mutually incompatible devices proliferate. To assess the impacts we will develop scenarios for the number and type of chargers produced and discarded per year in the EU via a dynamic stock model (for further detail on this please refer to the proposal).

To carry out this assessment we will define a handful of environmental profiles for chargers within the stock model. These will assume no difference in environmental impact due to the cable type (since cables differ only marginally in terms of

[22] For example, we used this approach to consult SMEs in an evaluation commissioned by the British Business Bank that aimed to assess the economic benefits of a venture capital fund. We used interviews to gather qualitative information, while quantitative data on funding, employment, GVA and R&D investment was collected through datasheets.

their composition and therefore resource use and waste implications). However, differences may result from the different external power supply solutions (charging blocks), for instance:

- Standard charger
- Fast charger (USB-PD) – includes Apple and Huawei (SuperCharge)
- Fast charger (QuickCharge) – includes Samsung
- Proprietary charger – if this category is deemed necessary, e.g. if there is a charger type with significant market share that has significantly different environmental (or other) characteristics

We also intend to not only estimate the benefits of any reductions in the weight numbers (e.g. tonnes) but also provide a more in-depth assessment of the economic and environmental value of these. The values can be quantified drawing upon life cycle impact analysis (LCIA) assessments of chargers or of the associated devices.Approaches are also available to monetise the impacts and/or savings achieved, the use of these are to be further discussed with DG GROW. Key variables / assumptions to be verified / updated as well as key literature are discussed in the Annexes.

Summary of stakeholder consultation methods

As part of this study, we will consult and collect information from stakeholders (including consumers and industry representatives, as already discussed above, as well as other stakeholders) via the following main methods:

1. Public consultation, addressed to interested parties at large, including potentially all stakeholders as well as EU citizens (see Annex I for further details);
2. An online panel survey of a sample of around 5,000 consumers (as mentioned above; for further information see Annex II).
3. 45 in-depth interviews with representatives of the following stakeholder groups (for a more detailed breakdown of the stakeholders to be interviewed, see Annex III):
    a. Industry representatives (number increased from 15 to 30 interviews, based on the considerations outlined above), including mobile phone manufacturers, charger manufacturers, and selected other industries,
    b. Public sector representatives (10 interviews), including international standardisation bodies and relevant national authorities of EU MS.
    c. Civil society (5 interviews), including consumer, environmental and product safety organisations.

Market analysis

To further refine the problem definition and to provide required input data into our market stock model, we intend to undertake a comprehensive market review. Below we provide an update of what specific elements we intend to include in the market analysis, and how we plan to undertake this part of the work.

The market analysis for mobile phones will primarily be a desk-based research task, using existing market data to estimate the supply and demand of mobile phones (market size, market volume, market value shares, retail prices for individual OEM and non-OEM chargers, different phone models in use and their market share) in the EU28. This can be summarised into four topic areas, as seen below.

- **Analysis of mobile phones and smartphones in use across EU28:** Mobile phone ownership/subscriptions, sales to end users, imports and penetration by country. This will give an up to date estimate of the ownership of mobile phones within the EU and will account for those people who own more than one device which will help to estimate the total number of mobile phones.

- **Analysis of the mobile phones and smartphones manufactured in EU28:** Exports, mobile phone production, end user sales, average selling price and revenue of EU28 based manufacturers. This will help quantify how many mobile phones are produced in the EU28 and potentially the economic impact on manufacturers as a result of each policy option.

- **Distribution channels of mobile phones and smartphones analysis:** Avenues and methods of distribution both online, and offline. This will help highlight the supply chain structure of mobile phone distribution and will show which stakeholders are most likely be impacted by the evaluation.

- **Market structure of mobile phones and smartphones:** Market share, volume and value shares by manufacturer, phone type, operating system, mobile phone manufacturer revenue, sales, and shipments. This will provide an understanding of the costs and benefits of the policy options and the willingness of market leaders to comply with each of the policy options – it will also provide required inputs into the market stock model. It will also help to provide a detailed analysis of the current degree of interoperability between the phones and chargers in use

The category of mobile phone chargers can be subdivided into two more categories, those sold in the box, and those sold separately (standalone chargers). Figures based on in the box chargers will be heavily reliant on data of mobile phone production by manufacturer or phone type so that an estimate can be made. By knowing the mobile phone type, an assumption can then be made about the relevant charger, whether that be a standard, proprietary or fast charging solution.

Our review of secondary data suggests that there there is good coverage of data on mobile phones themselves, but a lack of market statistics on (1) standalone charges and (2) the illicit market. No data sources has been identified to inform our analysis of standalone chargers specifically. Similarily, there is little to no data on the market for illicit chargers, although anecdotal evidence suggests that this does appear to be a genuine problem both in terms of technological performance and health & safety standards. We will explore this further in our interview programme, but additionally we suggest to consult experts at the European Observatory on Infringements of Intellectual Property Rights.

Therefore, when estimating chargers on a standalone basis, we will replicate the method as used in the RPA study which provided an estimation based on the proportion of chargers sold on a standalone basis compared to those sold in the box.

To validate our estimates of standalone chargers sold further, from the planned consumer panel survey, we will ask consumers how many standalone chargers they have bought in the past years. These individual responses will then be extrapolated from the participating countries and aggregated to firstly a country level, and then to an EU level.

Altogether, this approach should allow us to present information on:

- **The types of chargers used per mobile phone manufacturer:** The charging solutions per manufacturer or phone type (including standard, proprietary, fast charging and wireless). This will allow the assessment of the effectiveness of the previous MoU in guaranteeing interoperability over time as well as establishing a baseline of current levels of interoperability.

- **Analysis of the demand and supply of standalone phone chargers:** Consumer use and current demand of standalone chargers will be estimated from the consumer survey. We will attempt to gather information on the supply side of standalone chargers through a combination of direct consultations with manufacturers (both phone and charger manufacturers) and estimations based on new mobile phones sold with a relevant charger.

- **Distribution channels of mobile phone charger analysis:** Avenues and methods of distribution both online, and offline are likely to be similar to those of mobile phones. In addition, we will undertake a qualitative review of up to three main online retail platforms (such as Amazon, Ebay) and secondary literature will shed light of how the markets for non-OEM chargers and illicit chargers are structured and organised.

- **Market structure of mobile phone chargers:** Type of chargers sold and in use, broken down by type of connector and EPS, non-OEM, OEM and level of interoperability will be synthesised as described above, presenting a complete picture of the current market structure and informing our impact assessment of individual policy options.

4.5 Comparing the options

The final step in the IA study will be the comparison of the aggregated impacts of all the options. Based on the policy options and impact screening presented above, we propose to structure the comparison of the options in two parts, a simple Cost Benefit Analysis and simple (no weighting or ranking) Multi-Criteria Analysis. This will combine the results from the impact analysis to enable an objective comparison of the relative costs, benefits and impacts of the options. Examples of the proposed final assessment tables are presented in the Annexes. The tables will be supported by more detailed discussion in text, and possibly sub-tables, providing more in-depth analysis and discussion of the distribution of the impacts, the spread across materials and geographies and the most affected parties.

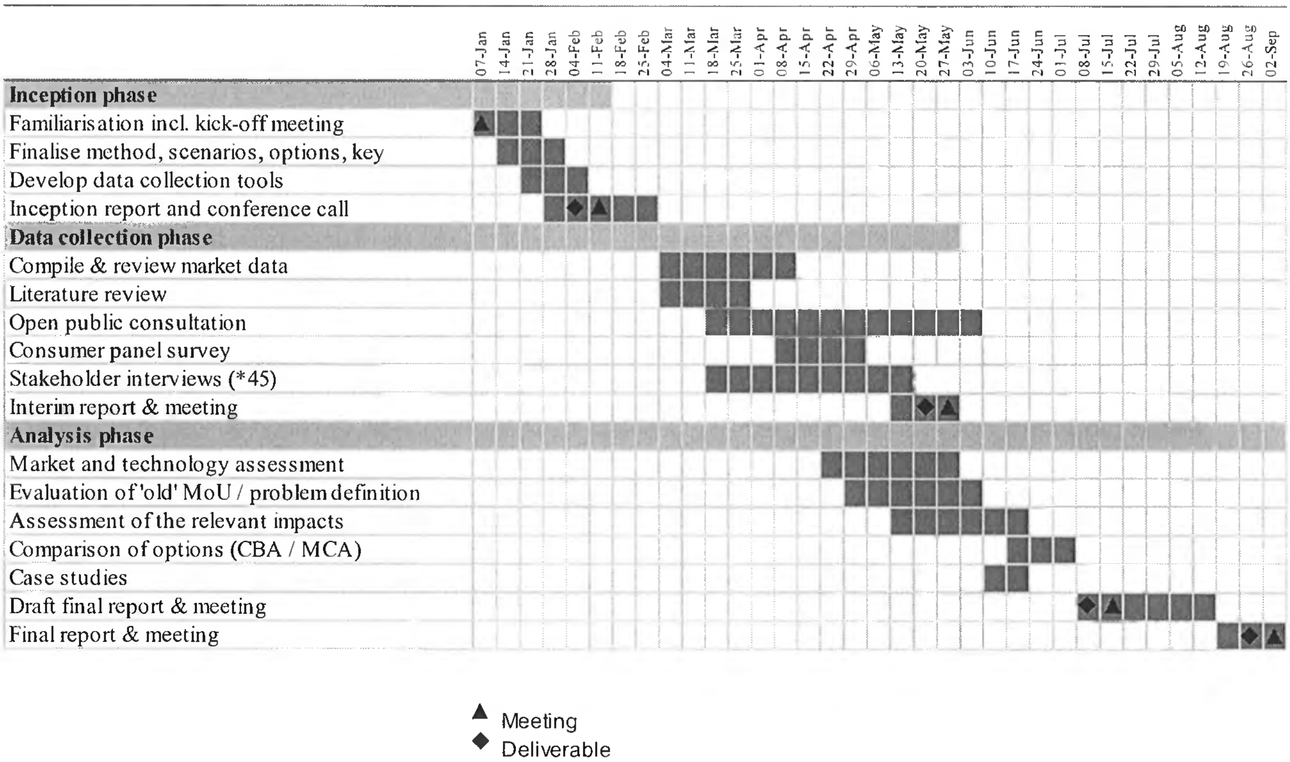
Limitations to this approach stem from the assumptions that will need to be made and employed in the stock model, e.g. on production costs, charger weight and composition. Whilst these will draw on the best available evidence, it is also the case that they will rely to a large extent on stakeholder input and our expert judgement. This will add uncertainty to the analysis. Sensitivity testing of key assumptions will help to identify and quantify this level of uncertainty.

5 Updated workplan

This section presents our updated work plan based on the timelines agreed during the kick-off meeting with DG GROW. The submission of this Report (the Inception Report) is the first milestone of the project. Next key milestones are as follows:

- Submission of interim report in w/c 20 May 2019
- Submission of draft final report in w/c 8 July 2019
- Submission of final report in w/c 26 August 2019

Table 5.1: Updated workplan



In terms of **next steps** that will need to be taken to facilitate delivery of the study in line with the timetable above, we would like to highlight the following:

- **Conference call**: A conference call held on 15 February provided an opportunity for DG GROW to share its feedback, and in particular to discuss the proposed policy options, and the approach to the public consultation and consumer panel survey. The present version of this report has been revised to address the Commission's comments.
- **Launch of consultation activities**: The aim is to launch the public consultation and the stakeholder interview programme in March, and the consumer panel survey in April. For this purpose we will need to finalise the

research tools (questionnaires and topic guides), taking into account DG GROW's comments on the content of this report. The tools will be submitted to DG GROW for sign-off before the consultation activities are launched.

- It is worth noting that both **questionnaires will need to be translated** – the one for the public consultation by the Commission (into all official languages), the one for the consumer survey by Ipsos (into the local languages of the ten selected countries). This needs to be factored into the timetable, and emphasises the need to have a final agreed version of both questionnaires ready as soon as possible.

Annexes

Annex I: Public Consultation

In accordance with the Commission's Better Regulation Agenda, a "12 week internet-based public consultation must be part of the consultation strategy for initiatives supported by impact assessments, evaluations and fitness checks".[23] This is intended to provide all interested parties an opportunity to contribute their views and opinions.

A draft questionnaire for the consultation was included in the draft inception report, and subsequently revised by the European Commission. The study team has provided feedback to the latest draft as per email on 28 February 2019.

We expect that the public consultation will be translated into all official EU languages by European Commission services and will be implemented using the EU survey tool.

The technical implementation of the consultation (including uploading the questionnaire, publicising and formally launching the consultation) will be the responsibility of the Commission services in charge of the Your Voice in Europe website. We are open to providing input to the Commission as regards possible channels for disseminating and publicising the consultation and stand ready to also use our own networks and channels (e.g. Twitter feed). The consultation will remain open for 12 weeks. Throughout this period, we will seek to obtain from the Commission updates on the number of responses received (e.g. after 4 weeks, 8 weeks, 10 weeks and 11 weeks).

[23] Better Regulation Guidelines, Chapter VII: Guidelines on Stakeholder Consultation

Annex II: Consumer survey

The consumer survey will provide qualitative evidence around individual consumption, in addition to quantitative responses where this is not covered within available market data (see our discussion of available market data below). The total length of the questionnaire will not exceed 15 minutes.

A draft questionnaire of the consumer survey will be shared with the European Commission separate from this revised inception report - including the following key modules.

Table 5.2: Draft structure of the consumer survey questionnaire

Module	Reference	Focus
Intro (1 min)		Age, internet use
A (1 min)	Chargers in use, and nature of use	Current mobile phone model(s) and chargers in use by consumer, year of purchase
B (1 min)		Current use of accessories (fast charging and/or wireless charging solutions, adapters), year of purchase
C (1 min)		Nature of use (i.e. whether mobile phone chargers are used to charge other devices)
D (1 min)		Average lifetime of mobile phones and chargers, way of disposal
E (5 min)	Conjoint analysis (choice based)[24]	Matrix suggestion different bundles of phone models with harmonised/non-harmonised chargers as well as phones sold without chargers / charging solutions sold separately, describing features of each bundle. Prices will be assigned to each bundle through market research on major online sales platforms.
F (5 mins)	Consumer detriment[25]	Extent to which consumers had problems with charger, types of problems experienced (lacking interoperability, safety, suboptimal performance) and impacts of these problems (costs occurred, and time spent)
G (1min)	Close	Interview close

The design of the module E will most likely be in the form of a standard choice based conjoint questionnaire. This will allow analysis based on the relative importance of a products attributes or levels, in this case, the type of charging solution offered (if at all) and any external attributes influencing these preferences (such as the type of mobile phone owned, nature of use and other items to be included in modules A-D of the questionnaire.

The survey will be conducted across 10 countries: Germany, France, Italy, Poland, Spain, Hungary, the Netherlands, Romania, the Czech Republic and Sweden, each with a sample size of 500, in line with population representation statistics as outlined by Eurostat in the technical proposal.

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[24] https://en.wikipedia.org/wiki/Conjoint_analysis

[25] See the Consumer Engagement and Detriment Survey 2014 for an example of how module F could be detailed out https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/319043/bis-14-881-bis-consumer-detriment-survey.pdf

Annex III: In-depth interviews with stakeholders

The table below provides a summary overview of the split of the 45 interviews we intend to conduct across different stakeholder groups and sub-groups.

Category	Type of stakeholder	Number of interviews	Proposed stakeholders
Public sector (10 interviews)	EU bodies	2	European Parliament, DG GROW
	Standardisation bodies	3	CEN-CENELEC, ETSI, Institute for Electrical and Electronic Engineers (IEEE), or American National Standards Institute (ANSI)
	National authorities	5	Market surveillance authorities for electrical appliances and equipment under LVD and other relevant authorities to be selected.
Industry (30 interviews)	Mobile phone manufacturers	10	2018 MoU signatories (Apple, Google, Lenovo, LG Electronics, Motorola, Samsung, Sony Mobile) Huawei, BQ, Fairphone
	Charger manufacturers	6	Belkin, Anker, APE. List to be completed during data collection phase to ensure: a) geographic distribution, including European companies; b) large companies and SMEs. Phone manufacturers and industry associations are expected to provide details on main charger manufacturers.
	Industry Associations (representing mobile phones and other portable devices manufacturers)	2	Digital Europe, Mobile & Wireless Forum
	Manufacturers of other portable devices	4	Indicatively: One smart watches manufacturer (e.g. Polar), one camera manufacturer (e.g. Nikon), one laptop manufacturer (e.g. Dell), one e-reader manufacturer (e.g. Amazon)
	Distributors of phones and chargers, online and offline	3	Industry associations of mobile operators (GSMA/ETNO), Associations of retailers (Eurocommerce, EMOTA)
	Other industry bodies	5	Qualcomm, Intel, USB Implementers Forum, RECHARGE, The App Association
Civil society (5 interviews)	Consumer organisations	2	ANEC, a national consumer organisation
	Environmental NGOs	2	ECOS, WEEE Forum
	Product safety organisations	1	Electrical Safety First

Identifying industry contacts – We will attempt to consult manufacturers of mobile phones, chargers and certain other devices. However, identifying the individuals able to respond to questions we intend to pose and, identifying a meaningful selection of manufacturers of mobile phone chargers, could prove challenging.

To mitigate these challenges, we will employ a mixed method to identify individual contacts to be included in our contact list for industry consultations. First, a list of relevant companies will be drawn up through desk review and an analysis of market data. Next, we will attempt to construct a contact list covering the companies identified. Industry representatives in relevant European Commission working groups such as the TVAM and LVD working groups will be added in a first instance, and industry associations such as Digital Europe will be asked to nominate individuals from their member organisations. We anticipate that the identification of charger manufacturers will be particularly challenging – whilst manufacturer lists exist for fast charging solutions (e.g. using Qualcomm's quick charge standard), other manufacturers will have to be identified through talking to phone manufacturers first and using supplier lists online[26], as well as a review of product and brands available via major platforms such as Amazon. To ensure that we speak to the most relevant individual, contacts on the resulting contact list will be provided with a list of topics to be discussed and asked to confirm that they are willing to undertake the in-depth interview. In cases where contacts reply with a negative response, we will ask for an alternative colleague to be nominated at the same firm.

[26] https://www.globalsources.com/manufacturers/USB-Charger.html

Annex IV: Cost benefit analysis and multi criteria analysis – exemplary tables

Table 5.3: Example final cost benefit analysis results table

	Baseline option: Industry MoU	Option 1	Option 2	Option 3
Impact on consumers				
Consumer cost [EUR]				
Impact on economic operators				
Production cost [EUR]				
Revenues [EUR]				
Change in EU GVA [EUR]				
Environmental impacts (only if monetised)				
Raw materials consumption [EUR]				
CO_2 emissions [EUR]				
Total cost/benefit				

Table 5.4: Example final multi-criteria analysis results table

	Unit	Baseline option: Industry MoU	Option 1	Option 2	Option 3
Impact on consumers					
Consumer inconvenience	[+/-]				
Impact on economic operators					
Employment	['000 FTEs]				
Administrative burden / simplification	[+/-]				
Environmental impacts					
Raw materials consumption	[tonnes]				
E-waste generated	[tonnes]				
CO_2 emissions	[tonnes]				
Sustainable Consumption and Production	[+/-]				
Other impacts					
Impact on innovation	[+/-]				
Impact on competitiveness	[+/-]				
Impact on safety	[no. of incidents]				
Impact on illicit markets	[market size – EUR]				

Annex V: Assessment of environmental impacts – key variables, assumptions and literature

Table 5.5: Key variables/ assumptions to be investigated to assess environmental impacts

Key variables	Source/ description of assumptions
Decoupling rate	RPA 2014 study estimated a 0.02% decoupling rate of EU handset shipments between 2011-2013, we will need to assess to what extent this holds and how it could look like in the future (scenarios). This will be part of the market analysis.
Weight of a charger	RPA 2014 study found that there might not be a correlation between the size (and hence weight) of a charger and the power supplied by it. They also indicate the average weight of a charger to be in the range of 60-270 grammes.[27] Literature will be reviewed as well as direct measurements of weight done by the team. A preliminary literature review done by the team indicates that the size and weight of a charger are aligned with the RPA study. A review comparing two original chargers (Apple vs Huawei) of similar size, found that the Huawei charger was capable of providing more than three times the power output[28], supporting the finding of the RPA 2014 on the correlation between the size/ weight and the power output. Moreover, a source[29] points to the fact that "fake" chargers are often lighter than "original" chargers, which can be attributed to for example missing components for protection.
Material composition of different chargers	It will be important to assess the shares of different materials in a charger, including plastics, metals, and other materials. Also what share of the materials are recyclable. The RPA 2014 study assumed that 30% of materials in a charger are recyclable.[30] Scientific literature and expert judgment will be used to test this assumption and assess material composition of different chargers.
Market penetration of different chargers	It will be important to estimate the market shares and market size of different charging solutions, not only to assess the environmental impacts but also other impacts. This will be part of the market analysis.
The impact of proprietary devices on interoperability	This will include the assessment to what extent additional chargers or its components, such as adaptors are needed. This will be part of the market analysis using the information from consumer survey on the amount of chargers owned, used and bought.
Retention rate	This includes collecting data on the retention rate of chargers. This rate measures the % of chargers in a household that are retained, i.e. not disposed of or lost. Such information will be collected through the consumer survey by asking consumers the number of chargers their own and use compared to the total number of chargers they had and/ or by specifying the number of chargers they disposed of or lost.
Recycling/ disposal rate	This includes collecting data on the recycling/ disposal rate. The RPA study estimated a 4% recycling rate of old chargers, assuming the recycling rate of chargers is the same/ similar to the recycling rate of mobile phones, reviewed in a survey.[31] In this project, through the consumer survey, we will ask consumers how many chargers out of total they disposed of and recycled.

Examples of other estimates include and GSMA (2009) - 85 grams and Techweek (2013) - 187 grams (http://www.techweekeurope.co.uk/news/nokia-301-o2-charger-usb-123281).; Sainsbury (2010): Sainsbury to Conquer the Mobile Phone Charger Mountain, available at http://www.j-sainsbury.co.uk/media/latest-stories/2010/20100801-sainsburys-to-conquer-the-mobile-phone-charger-mountain/; Bolla et al (2011)

Chargerlab, 2018, Huawei 40W SuperCharge Wall Charger Teardown, available at http://www.chargerlab.com/archives/1113.html[28]

Earlier this year Chargerlab did a teardown of a fake "Apple" charger and compared its internal quality with the original Apple product, Chargerlab, 2019, Fake "Apple" 18W USB-C Charger Teardown. Is it dangerous? ,available at http://www.chargerlab.com/archives/1778.html

Environmental Leader (2012): AT&T Launches Low-Energy, Recycled Content Chargers, available at http://www.environmentalleader.com/2012/09/04/att-launches-low-energy-recycled-content-chargers/

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

Key variables	Source/ description of assumptions
CO_2 emissions savings per charger	The RPA 2014 study assumed based on literature sources that around 580 grams to 1.6 kg of CO_2 eq can be avoided per charger if this is not supply with the handset and not produced.[32] We will review scientific literature to confirm or update these assumptions.

Table 5.6: Screening of existing literature on environmental impacts of chargers

	Author	Year	Description
Environmental Screening and Evaluation of Energy-using Products (EuP) Final Report[33]	Danish Ministry of the Environment	2009	Chapter 9 on Battery chargers and external power supplies includes an environmental screening based on the Ecoinvent database.
Redefining scope: the true environmental impact of smartphones?[34]	Suckling, L. and Lee, J.	2015	Chapter 8 on Charger specifications and if/how they are included or not in the LCA of the screened literature. Impacts listed are standby charger energy consumption (also called "standby drain").
Life Cycle Assessment of a Smartphone[35]	Ercan, M. et al	2016	A cradle-to-grave LCA of two models of Sony Corporation's smartphones, including a list of recommended environmental LCA indicators.
Analysis of material efficiency aspects of personal computers product group[36]	Joint Research Centre	2018	The Bill of Materials of External Power Supplies (EPS) for laptops and their Environmental impacts are listed, including details about USB and connectors.
Environmental benefits of a universal mobile charger[37]	Bolla, R. et al.	2011	A summary of the findings of a previous study on the LCA characteristics of a wide range of mobile-phone chargers. The article highlights similarities, differences and improvement opportunities.
Global Warming Potential of a Smartphone Using Life Cycle Assessment Methodology[38]	Ercan, M.	2013	An evaluation of the potential environmental impacts of a smartphone, in particular the model Sony Xperia, using a LCA methodology. A description of the charger and USB cable is included, as well as estimates of the global warming potential of the phone charger and USB cable throughout a lifetime of 3

Sources include: Fairphone (2014), Guvendik, Next step in Life Cycle Assessment: Inventory analysis, accessed at: https://www.fairphone.com/2014/06/20/next-step-in-life-cycle-assessment-inventory-analysis/; Royal Institute of Technology (2013): Global Warming Potential of a Smartphones, accessed at http://kth.diva-portal.org/smash/get/diva2:677729/FULLTEXT01.pdf; ITU (2011): Environmental benefits of a universal mobile charger, accessed at https://itunews.itu.int/en/1944-Environmental-benefits-of-a-universal-mobile-charger.note.aspx

Ch9 https://www2.mst.dk/udgiv/publications/2009/978-87-92617-03-3/html/kap09_eng.htm; full report URL: https://www.researchgate.net/publication/238728444_Environmental_Screening_and_Evaluation_of_Energy-using_Products_EuP_Final_Report

Suckling, J. & Lee, J. Int J Life Cycle Assess (2015) 20: 1181. https://doi.org/10.1007/s11367-015-0909-4

Ercan, M. et al. (2016). Life cycle assessment of a smartphone. Paper published and presented at: ICT for Sustainability (ICT4S), Amsterdam, 30-31 August 2016. Available at: http://www.atlantis-press.com/php/download_paper.php?id=25860375

Tecchio, P. et al. (2018), Analysis of material efficiency aspects of personal computers product group, EUR 28394 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-64943-1, doi:10.2788/89220, JRC105156.

Bolla, R. et al. (2011): Environmental benefits of a universal mobile charger, ITU News, accessed at: https://itunews.itu.int/en/1944-environmental-benefits-of-a-universal-mobile-charger.note.aspx

Ercan, M. (2013), Global Warming Potential of a Smartphone Using Life Cycle Assessment Methodology, Master of Science Thesis, Royal Institute of Technology, Stockholm, 2013. Accessed at: http://kth.diva-portal.org/smash/get/diva2:677729/FULLTEXT01.pdf

	Author	Year	Description
			years.

Annex VI: Initial review of secondary market data available

Table 5.7: overleaf presents the results of our review of secondary data, and the extent to which both publicly available datasets and other sources might inform the planned market analysis. From this review, it appears that Eurostat, Statista as well as IDC reports together should provide the most comprehensive evidence.

Table 5.7: Review of available datasets

Source	Variables covered	Countries covered	Years covered	Breakdowns available	Costs
EuroStat Prodcom (prom2, DS-066341, PRCCODE: 26302200) – Telephones for cellular networks or for other wireless networks – NACE Rev.2	Production - export quantities, export values, import quantities, import values	EU 28	1995-2017	Individual countries	Free
EuroStat Prodcom (prom2, DS-066341, PRCCODE: 27904140) – Power supply units for telecommunications - NACE Rev.2	Production - export quantities, export values, import quantities, import values, product quantities, product value	EU 28	2016-2017	Individual countries	Free
The World Bank	Mobile cellular subscriptions (per 100 people)	European Union	1985-2017	Individual countries	Free
Canalys	Smartphone shipments in units, value and price, brands. Market shares by vendor, model, country/region including features such as battery capacity and fast charging	33 countries in the EMEA	varies	Quarterly or yearly, mobile phone type and model, manufacturer, platform, battery capacity, fast charging	No quote received
Statista	Market share and number of units for mobile phones, shipments by smartphone vendor; Share of global mobile phone shipments 2008-2020; Number of mobile phone subscriptions worldwide from 1993-2017; Global smartphone sales to end users 2007-2017, Global smartphone unit shipments 2019; Number of imported telephones in EU – 28 2011/2015; Smartphone market in Europe report, market share of individual smart phone models	Western Europe and Eastern Europe (some EU member states missing)	varies	Country (but some EU member states missing)	$50/month for a minimum of 12 months
GSMA Intelligence	Number of mobile phone subscriptions in Europe, type of contract, type of phone	EU28	2006-2017	Country, region, type of subscription	£12,000 / month for full access

Source	Variables covered	Countries covered	Years covered	Breakdowns available	Costs
IDC	Shipment units by phone model and manufacturer, distribution channel, installed base, price segments	Western Europe (16): Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the U.K. Central and Eastern Europe (12): Bulgaria, Croatia, Czech Republic, Hungary, Kazakhstan, Poland, Romania, Russia, Serbia, Slovakia, Ukraine, and Rest of Central and Eastern Europe	2017 - 2018 (only available 18 months back)		unclear

For more information

3 Thomas More Square
London
E1W 1YW

t: +44 (0)20 3059 5000

www.ipsos-mori.com
http://twitter.com/IpsosMORI

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