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IMPACT ASSESSMENT REPORT

Accompanying the documents

Commission Regulation

laying down ecodesign requirements for smartphones, mobile phones other than smartphones, cordless phones and slate tablets pursuant to Directive 2009/125/EC of the European Parliament and of the Council and amending Commission Regulation (EU) 2023/826

and

Commission Delegated Regulation

supplementing Regulation (EU) 2017/1369 of the European Parliament and of the Council with regard to the energy labelling of smartphones and slate tablets

{C(2023) 1672 final} - {C(2023) 3538 final} - {SEC(2023) 164 final} -
{SWD(2023) 102 final}

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Glossary

Term or acronym	*Meaning or definition*
3TG	tin, tungsten, tantalum, gold; metals stemming potentially from conflict minerals
5G	5th generation mobile communication
AI	Artificial Intelligence
Bitkom	German association representing the digital economy
CEAP	Circular Economy Action Plan
CEI	Circular Electronics Initiative
CO_2 eq.	Carbon dioxide-equivalents in terms of greenhouse gas effects
EEE	Electrical and Electronic Equipment
EPR	Extended Producer Responsibility
EPREL	European Product Database for Energy Labelling
GHG	Greenhouse Gases
IC	Integrated Circuit
ICT	Information and Communication Technology
IP	International Protection / Ingress Protection, Intellectual Property
IT	Information Technology
kWh/a	kilowatt hours per year
LCA	Life Cycle Assessment
MIL-STD	US military standard
mt	Million tons
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne
OEM	Original Equipment Manufacturers(s)
OS	Operating System

PC	Personal Computer
PCB	Printed Circuit Board
PJ	Petajoule
SME	Small and Medium-sized Enterprises
SO_2 eq.	Sulphur dioxide emissions equivalents, contributing to the environmental impact acidification
t	Tons
TWh	Terawatt hours
WEEE	Waste Electrical and Electronics Equipment

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

The European Green Deal is Europe's new growth strategy and aims to "transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use" (European Commission 2019b). Digital technologies will be a critical enabler for this transition, since new technologies such as artificial intelligence (AI), 5G, cloud and edge computing and the internet of things (IoT) can accelerate and maximise the impact of policies to deal with climate change and protect the environment. At the same time, the Green Deal also highlights the need to consider measures to improve the energy efficiency and circular economy performance of the information and communications technology (ICT) sector itself, from broadband networks to data and ICT devices.

The second Circular Economy Action Plan[1] (CEAP 2020) was published by the Commission in March 2020. It gives a high priority to ICT and electrical and electronic equipment in particular within the area "key product value chains", but also when it comes to empowering consumers and public buyers (European Commission 2020a). The CEAP 2020 announced the sustainable products policy framework that will provide high-quality, functional and safe products, which are efficient and affordable, last longer and are designed for reuse, repair, and high-quality recycling. To address the specific challenges in the electronics and ICT sector, the Circular Electronics Initiative (CEI) has the objective to promote longer product lifetimes[2]. It also foresees regulatory measures on chargers for mobile phones and similar devices. Another action of the CEI is related to improving the collection and treatment of waste electrical and electronic equipment (WEEE), e.g. by exploring options to incentivise the take-back and return of small electronics such as old mobile phones, tablets and chargers. On the demand side, the CEAP 2020 envisages to empower consumers and public buyers through several measures, such as the revision of the EU consumer law, strengthening consumer protection against green washing and premature obsolescence, setting minimum requirements for sustainability labels/logos and for information tools (European Commission 2020a). In addition, the future legislative initiative for a right to repair will promote a more sustainable and longer use of goods, e.g. through providing incentives for consumers to repair products.

Another measure announced in the Green Deal is a legislative proposal on batteries that the Commission published in December 2020. It includes a variety of proposed measures, including collection and recycling targets and sustainability requirements. For sustainability requirements such as carbon footprint and recycled content it focusses on

[1] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A new Circular Economy Action Plan For a cleaner and more competitive Europe. COM/2020/98 final

[2] See annex 6 for the articulation between the initiatives discussed in this impact assessment and other legislative and non-legislative initiatives under development by the European Commission in fields related to product policy, circular economy and consumer rights.

large batteries (mainly electric vehicle batteries and industrial batteries). For sustainability requirements on performance and durability it focusses on large batteries and on (non-rechargable) portable batteries of general use (‘AA’, ‘AAA’ etc. formats), but it does not address performance and durability of other categories of batteries such as those for mobile phones and tablets (European Commission 2020b). Mobile phones and tablets also contain conflict minerals (tantalum, tungsten, tin and gold) which are regulated under the Conflict Minerals Regulation (Regulation (EU) 2017/821).

Not only the EU, but also some Member States are advancing on circular economy policies and legislation. As an example, France adopted a new circular economy and anti-waste law in 2020 with numerous measures, among others introducing a reparability index[3] (see Annex 5).

One goal of the Commission announced in the CEAP 2020 is to work on regulatory measures for electronics and ICT (incl. mobile phones, tablets and laptops) under the Ecodesign Directive to ensure that devices are designed for energy efficiency and durability, reparability, upgradability, maintenance, reuse and recycling. Laptops are in scope to the already existing Ecodesign Regulation 617/2013 on computers, and are also currently under review.[4] The Commission has therefore announced two specific and complementary initiatives 'Designing mobile phones and tablets to be sustainable – ecodesign'[65] and ‘Energy labelling of mobile phones and tablets – informing consumers about environmental impact’[71]. An Ecodesign preparatory study on mobile phones, smartphones and tablets was launched by the Commission in 2020, resulting in a final report published in March 2021 (European Commission 2021). The information and data evidence gathered within this study show a potential, in particular for Ecodesign requirements on material efficiency aspects, but also for energy labelling (Annex 7 presents an overview on the functioning of the Ecodesign Directive and the Energy Labelling Regulation). The overall objective of this Impact Assessment is to build on the results of the preparatory study and other studies and to provide environmental and techno-economic analysis and scientific support for the policy-making process regarding possible regulatory measures on mobile phones and tablets, as referred to in the abovementioned initiatives[65, 71].

At the time of the drafting of the current impact assessment (Q3 2021), a number of legislative and non-legislative initiatives was under development/already developed by the European Commission in fields related to product policy, circular economy and consumer rights, such as the Ecodesign for Sustainable Products Regulation, the Circular Electronics Initiative and the Common charging solution initiative. Annex 6 presents and describes in

[3] Loi n° 2020-105 relative à la lutte contre le gaspillage et à l’économie circulaire

[4] See https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1581-Review-of-ecodesign-requirements-for-computers-and-computer-servers_en for the review of Regulation 617/2013. The reasons for covering smartphones and (slate) tablets under the same Ecodesign Regulation, as well as for keeping laptops under the review of the Ecodesign Regulation 617/2013, are discussed in detail at the beginning of Annex 9.

detail the articulation of the two initiatives on the Ecodesign and Energy Labelling of mobile phones and tablets with the other ones under preparation or recently proposed by the Commission.

2. PROBLEM DEFINITION

2.1. What is the problem and why is it a problem?

In 2020, around 150 million mobile phones and 23.90 million tablets were sold in the EU. The overall stock on the EU market is estimated to be around 450 million for mobile phones and around 150 million for tablets (European Commission 2021). According to Eurostat, there were on average 1.2 mobile subscriptions per person in the EU in 2018 (Eurostat 2020). The functionality and popularity of smartphones and tablets has been increasing over time, which resulted in increased energy demand and materials needed to manufacture them (see Annex III for an overview of the manufacturing industry).

Energy use of mobile phones, cordless phones and tablets

The total EU primary energy consumption of the installed base of mobile phones and tablets in 2020 over their lifecycle (including production, use and disposal) was 39.5 TWh (ca. 0.25% of total EU27 primary energy consumption[5]), thereof 28.5 TWh (72%) for smartphones, 1.6 TWh (4%) for mobile phones other than smartphones, 1.8 TWh (5%) for cordless phones and 7.6 TWh (19%) for tablets (European Commission 2021).

Contrary to many other energy-related products, short-living ICT products such as mobile phones and tablets have a rather high energy use in upstream production processes compared with the actual product use. The supply and value chain of smartphones and tablets is usually long, complex and undergoes constant changes. Main components such as displays, processors, batteries, flash memory, cameras, radio interfaces (baseband chip), computer network interfaces, and audio components stem from different parts of the world including Asia, North America and to a small extent Europe. Printed circuit boards (PCB) of smartphones and tablets are typically produced in Asia. However, there are also some relevant EU based companies in this segment. The final production of the devices is predominantly located in East Asia, mainly in China (European Commission 2021). For this reason, a significant share of the primary energy consumption is related to the production outside of the EU (46%) and only 1% to the production within the EU.

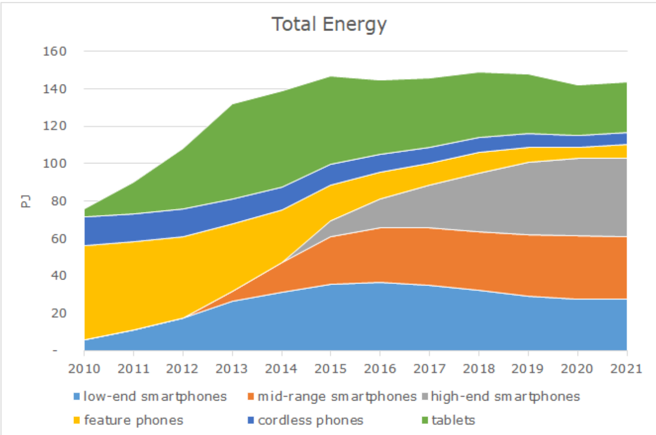
Of the 39.5 TWh total primary energy consumption of products on the EU market the share attributed to electricity consumption is 26.6 TWh (67%), including 11.4 TWh for production outside the EU, 0.2 TWh for production inside the EU and 15 TWh for use inside the EU. Total greenhouse gas emissions in 2021 for mobile phones are 7.0 mt CO_2 eq., for cordless phones 0.4 mt CO_2 eq., and for tablets 1.5 mt CO_2 eq., including the life cycle phase's production, distribution and use. Thereof, 4.9 mt CO_2 eq. are attributed to production (mainly outside the EU), 1.7 mt CO_2 eq. to distribution, and 2.2 mt CO_2 eq. to use within the EU. The total GHG emissions of the analysed products correspond roughly

[5] Source: Eurostat (NRG_BAL_C) based on EU27 data for 2019 (last year available)

to the total GHG emissions of Cyprus in 2019[6]. Total resource contents in products sold on the EU market in 2021 are estimated to amount to 5.3 t Tantalum (ca. 1.3% of EU annual average consumption[7]), 2.0 t Indium (ca. 3.1% of EU apparent consumption[7]), 36 t Rare Earth Elements (ca. 0.7% of EU consumption[7]), 1,200 t Cobalt (ca. 6.8% of EU apparent consumption[7]), among others (European Commission 2021).

With market saturation in recent years, the upwards trend of total energy use of mobile phones, cordless phones and tablets came to a hold in the EU (Figure 1) and stays relatively flat. There is little indication that this trend might be reversed in the future without policy intervention (European Commission 2021).

Figure 1: Total energy consumption of mobile phones, cordless phones, and tablets on the EU market, 2010-2021[8]



Resource intensive production

On average, more than 60 different elements are used for the production of smartphones (Bookhagen et al. 2020). Main materials are metals, glass and ceramics and plastics. Dominant metals are aluminium, copper and iron/steel alloys, but relatively small quantities of other raw materials that are classified as critical by the European Commission can also be found in smartphones and tablets. Critical raw materials combine raw materials that are of high importance to the EU economy and of high risk associated with their supply. Main examples include cobalt, lithium and rare earth elements (e.g. neodymium, dysprosium, terbium, gadolinium, etc.) as well as tantalum and tungsten (Cordella et al.

[6] Source: EEA greenhouse gases - data viewer. The total greenhouse gas emissions of Cyprus amounted to around 9.5 mt CO_2eq in 2019.

[7] Source: European Commission, Study on the EU's list of Critical Raw Materials (2020), Factsheets on Critical Raw Materials. The EU annual average consumption of tantalum over the period 2012-2016 was estimated to be around 395 t/y. The estimated EU apparent consumption of indium (production+imports–exports) was 64 t/y. The EU consumption of REE was 4,734 t/y of compounds (expressed in REO content) and 683 t/y of REE metals and interalloys during the 2016-2018 period. The apparent consumption of refined cobalt in the EU amounts to 17,585 tonnes of cobalt content per year on average during 2012–2016.

[8] The definition of the low-end (ca. 200 EUR; 2,400 mAh battery capacity; small 5" display), mid-range (ca. 500 EUR; 3,330 mAh battery capacity; mid-size 6" display), and high-end (ca. 1,000 EUR; 4,500 mAh battery capacity; large 6.5" display) segment follows the definitions set in the preparatory study.

2020). The latter two, next to tin and gold, are furthermore classified as conflict minerals (so called 3TG). On 1 January 2021, the Conflict Minerals Regulation (Regulation (EU) 2017/821) came into force across the EU ensuring the responsible sourcing of minerals among EU importers. A recent study (European Commission, 2022) confirmed that for the mobile telephone industry rare earths, used to make permanent magnets that are essential for components like microphones and speakers, are part of an area of strategic dependency for the EU (as the EU's production capacity covers only a limited share of EU demand and use).

The production of mobile phones and tablets is very resource intensive and Life Cycle Assessments (LCA) show that the highest impact for all environmental impact categories stems from the extraction of materials and the manufacturing processes (Proske et al. 2020b; Proske et al. 2016; European Commission 2021), see e.g. Figure 29. In manufacturing, the highest impacts on the global warming potential stem from integrated circuits (ICs) and PCB. Additional environmental impacts stem from the use of (critical) raw materials in main electronic components (Proske et al. 2020b; Proske et al. 2016). ICs have a high environmental impact coming from the energy-intensive processing of silicon wafers. The environmental impacts of precious metals (e.g. gold) are mainly related to upstream extraction and purification. Another substantial contribution comes from the PCBs, since the manufacturing of the substrate is a very energy-intensive process, which has a higher environmental impact than the used materials.

While the main environmental impacts occur in different parts of the world and mainly in Asia, fighting climate change (e.g. reducing GHG emissions), acidification, toxic and ecotoxic pollutants are global concerns and strategic policy goals for the Commission, e.g. the zero-pollution ambition which is a key commitment of the Green Deal[9]. The core principles of a Circular Economy are to design out waste and pollution, keep products and materials in use and to regenerate natural systems (Ellen MacArthur Foundation 2013). Today, there are several problems hindering mobile phones and tablets to reach these core principles.

1. **Current product design does not sufficiently incorporate Circular Economy requirements.**

In its 2021 review of EU actions and existing challenges on electronic waste, the European Court of Auditors highlights that ecodesign requirements do not yet encompass mobile phones (European Court of Auditors 2021). However, such requirements are needed to promote energy and material efficiency (durability, reparability, upgradability, maintenance, reuse, and recycling). The current design of most mobile phones and tablets does not sufficiently incorporate these aspects.

[9] https://ec.europa.eu/environment/strategy/chemicals-strategy_en

According to a Eurobarometer survey (European Commission 2020c), the main reason for users to purchase a new digital device was that the old device broke (37%). The most common technical lifetime limiting factors for smartphones and tablets are durability aspects linked to accidental incidents, such as display cracks after a drop on a hard surface, immersion of water and decreasing battery charge capacity over time (European Commission 2021).

Also, only few broken devices are currently repaired and from a design perspective there are numerous barriers to better technical reparability on the product and the support level (see Problem Drivers). A survey among German users revealed that 59% purchase directly a new smartphone when the old one is broken and only 11% try to repair it (OHA - Obsoleszenz als Herausforderung für Nachhaltigkeit 2019). Another survey in Austria unveiled that of all consumers with a defective phone, only 34% tried to repair it. From that share, 43% were broken beyond repair, 31% were reparable and 26% did not know how to repair it (Wieser and Tröger 2018). According to these figures, only around 10% of all defective phones were actually repaired. On the other hand, 77% of the respondents in another Eurobarometer survey indicated that they would prefer to have their products rather repaired instead of buying new ones, but eventually replace or discard them (European Commission 2014b).

Other important reasons for users to purchase a new digital device are that the performance of the old device had significantly deteriorated (30%) and that certain applications or software stopped working on the old device (19%) (European Commission 2020c). Software is part of product design and software-related support is considered crucial for the longevity of mobile phones and tablets, since the operating system (OS) has to be maintained through updates to fix bugs and to ensure data security. Updates and upgrades are also crucial for reuse. Currently, there are large differences in the market regarding the provided OS support, ranging from below one year to above five years (European Commission 2021). Insufficient software support can lead to premature product replacement, since the product is no longer functioning as required (e.g. lower performance). OS also evolve over time in terms of functionality features, and it is an important economic decision criterion for third party application developers which OS versions are supported and for how long. The partial lack of OS updates leads to challenges for software developers of third party applications, in particular to maintain various software versions and to support various OS generations in parallel, leading to incompatibilities in case an application developer decides to terminate the support for any current or historic OS version. In that sense, supporting mobile phones and tablets with most recent OS updates over an extended period of time is essential for overall functionality of the device and has a significant impact on final users, but also on application developers.

Within the public consultation (see Annex 2) carried out in relation to the two initiatives[10] under analysis in this impact assessment, some questions were specifically related to the reasons for which the respondent's previous smartphone is no longer in use. The need for fast/better performing /new devices, as well as the lack of availability of software and firmware updates, and the high repair prices, were among the most common replies[11].

2. It is too difficult for users to choose sustainable products at the point of sales.

There are strong indications that consumers are increasingly interested in considering sustainability criteria when purchasing new products such as smartphones and tablets. However, this information is currently not available at the point of sales and consumers cannot direct their choices towards more sustainable options.

A study conducted for DG JUST showed that consumers were generally willing to consider the durability and reparability of products when purchasing new products. Survey respondents indicated that they frequently searched for such information (62% for durability, 55% for reparability). However, they often felt that this information was difficult to find and would like to be better informed about these product characteristics. The same study delivered evidence that purchasing decisions might be strongly driven towards more circular economy friendly products when information on durability and reparability is provided in concise and comparable ways (European Commission 2018).

In a recent survey conducted by Bitkom, 72% of the participants stated that sustainability will be a decisive purchase criterion for their next smartphone (Bitkom e.V. 2020a). In the same survey, 86% of the participants indicated that they would consider a more robust display when purchasing their next smartphone and 82% stated that they will pay particular attention to the battery lifetime. Other important criteria for the participants were the production quality (85%), storage capacity (73%) and water ingress protection (66%). Another online survey among German consumers in 2017 (n=1813) came to similar results, showing that a long-lasting battery played a major role for 91% of the participants, while robust and durable design was an important choice criterion for 89%. Durability criteria found higher support in this survey than selected reparability criteria, such as the design feature that the device should be easy to repair (57%) and that the battery should be user-replaceable (52%) (Jaeger-Erben and Hipp 2018). Despite all these identified consumer preferences, the market situation still looks different, and it can be assumed that partly other criteria prevail when it comes to actual purchase decisions and as a matter of fact, transparency and comparability regarding several of the mentioned preferences is not given yet.

[10] 'Designing mobile phones and tablets to be sustainable – ecodesign' and 'Energy labelling of mobile phones and tablets – informing consumers about environmental impact'

[11] 611 replies were submitted for this consultation. 90% of the respondents were EU citizens that replied as individuals, with a net majority of Germans (more than 50% of respondents)

3. **Most products are replaced prematurely by their users.**

Surveys show that users usually expect their mobile phone to last around 5.2 years (Wieser et al. 2015). However, today's replacement cycles and actual use lifetimes are much shorter (see below). Short lifetimes increase the environmentally harmful demand for energy, critical raw materials, and potentially conflict minerals. For this reason, extending the active use lifetime can reduce the environmental impact. This can either be done by prolonging the replacement cycles (first use) and/or the potential further uses. A replacement cycle refers to the time when a user upgrades to a new model, ending the first use of the old device. It should not be interpreted as the end-of-life of the device, since mobile phones and tablets could be reused, either by giving them to relatives or friends, or by selling them to a re-commerce platform or through a second-hand channel. The first active use lifetime further depends on the durability of the device as well as its reparability and consumers' willingness to repair goods instead of replacing them once they break. The active use lifetime includes these potential further uses and comes to an end when the device is not further used and kept in hibernation (permanently switched off) or disposed of. In 2017, the average replacement cycle among smartphone users in Germany was around 21 months (1.75 years) – comparable to global replacement cycles (Lu 2017). Another analysis of five countries tracked by Kantar Worldpanel (France, Germany, Great Britain, Italy and Spain) showed that the replacement cycle of a smartphone was extended by nearly three months, from 23.4 to 26.2 months (2.18 years) between 2016 and 2018 (Ng 2019).

When it comes to the active use lifetime, a survey in Portugal came to the conclusion, that the average lifetime is 2.7 years for smartphones and 3 years for tablets (Martinho et al. 2017). Survey results from Belgium and France indicate a use lifetime of smartphones of 4.3 years and 3 years respectively (FNAC DARTY et al. 2019). The ICT Impact Study for DG ENER assumed an active use lifetime of 3 years for tablets/slates (Kemna et al. 2020), but the analysis conducted in the Ecodesign preparatory study found that this figure is underestimated. It concluded that smartphones are kept in active use for around 3 years, while tablets are kept in active use for around 5 years (European Commission 2021).

Within the public consultation (see Annex 2) carried out in relation to the two initiatives[10] under analysis in this impact assessment, a question was posed, to understand for how long did respondents use their last device. Nearly 45% of respondents used it for less than 3 years, whereas nearly 39% used it between 3 and 5 years.

This impact assessment report assumes a 'traditional' ownership model (the user buys and owns the device). Ownership models such as free/subsidised phones for subscriptions with mobile phone operators are not infrequent. However, based on the supporting information collected for this impact assessment (an analysis on the different ownership models for mobile phones, and their effect on the user behaviour, is presented under Annex 5), having free/subsidised phones implies behavioural changes (e.g. buying a new device because it was being offered under the contract with the network operator, and not because the old one is broken) only for a very small percentage of users (5%).

4. **At the end of their useful life, products are in most cases not returned back into the circular economy.**

Recent national studies show that many households do not discard old smartphones or tablets, but rather keep them at home in hibernation. A study conducted in France in 2019 concluded that 54-113 million old devices are hibernating in French households, of which more than two-thirds are still functioning (Sofies and Bio Innovation Service 2019). A recent survey conducted by Bitkom Research came to a similar conclusion, estimating that there are around 200 million mobile phones in hibernation in Germany, compared to 124 million in 2018 (Bitkom e.V. 2020b). At the European level, estimated stock of hibernating mobile phones is almost 700 million in the EU (European Economic and Social Committee 2019). Hence, there is a significant and steadily increasing untapped potential for collecting these devices, recovering valuable materials and disposing of hazardous substances in a safe way. This would also contribute to collection, recovery and recycling targets set out in the Directive on waste electrical and electronic equipment (WEEE).

Within the public consultation (for more details see Annex 2), a question was posed concerning the end-of-life of products (*what did you do with your last once you were no longer using it?*). The choice of 'hibernation' was the most stated one, with more than 45% of replies. To those choosing this reply, the reasons for this behaviour were asked. Nearly half of respondents did not answer, whereas 30% replied that 'I want to keep it as a backup/ an emergency spare, in case my new device does not work', 14% replied that 'I have no easy way to dispose of it properly or I do not know how to dispose of it properly' and 11% replied that they might need the device to retrieve old data. 8% of the respondents gave as a motivation the fear of security/privacy breaches when throwing away the device.

The WEEE Directive requires separate collection and proper treatment of WEEE (European Parliament and the European Council 2012): According to Article 7 and from 2019 on, the minimum annual collection rate shall be either 65 % of the average weight of electrical and electronic equipment (EEE) placed on the market in the three preceding years in the Member State concerned, or alternatively 85 % of WEEE generated on the territory of the Member State. On the EU level in 2017 the collection rate of IT and telecommunications equipment (category 3 during the transitional period until 14 August 2018) was only 61%, which shows a significant improvement potential for this category[12].

Since 15 August 2018 and according to Annex III of the WEEE Directive, mobile phones and tablets fall in category 6 related to small IT and telecommunication equipment (no external dimension more than 50 cm). The minimum recovery target for this category is

[12] Source : Eurostat dataset env_waselee. Calculation was performed for EU, based on the average weight of products put on the market between 2015 and 2017 (in tons) and divided by waste collected in 2017.

75% and 55% for preparation for re-use and recycling. In its recent review on EU actions and existing challenges on electronic waste, the European Court of Auditors came to the conclusion that even if the EU would achieve the minimum collection rate of 65 % for each of the WEEE categories, a large part of WEEE would still neither be recycled nor prepared for reuse. According to a hypothetical scenario, the EU would recover 48.75 % and recycle 35.75 % of its mobile phones (European Court of Auditors 2021), therefore missing the targets.

2.2. What are the problem drivers?

2.2.1. Market drivers

Negative externalities from production and consumption are not internalised

Smartphones and tablets belong to technologies that evolve very quickly. All major brands place new devices with higher performance, better functionality and more capacity on the market at least once every year (Cecere et al. 2015). As shown in the introductory part of the problem definition, this trend resulted in increased energy and material demand leading to considerable environmental impacts imposed on third parties at various locations around the globe that are currently not fully internalised.

Missing incentives for circular business models and sustainable production and consumption

Circular business models are built on the concept of value retention throughout a product's lifetime (EEA 2021). However, the dominant business models of the main manufacturers are currently still linear (take-make-dispose) and there are no clear incentives for change towards a more sustainable product design that would support longer lifetimes and an effective collection and recycling scheme at the end of a product's life.

Today, there is still a significant untapped potential to extend the active use lifetime of mobile phones and tablets (European Commission 2021; EEB 2019; EEA 2020). The reasons behind replacing these devices prematurely can be of behavioural and technical nature. On the technical side, replacements usually occur as a result of limiting events after which primary or secondary functions can no longer be delivered. Limiting events can be related to overload failures (e.g. broken/damaged screen, water/dust damages, etc.), wear-out failures (e.g. damaged connectors, low battery life, etc.) or reductions in performance or capacity that do not allow the product to function as required. These issues can be linked to both hardware and software (e.g. limited updates/upgrades) aspects (Cordella et al. 2021; European Commission 2021).

From a design perspective, there are basically two main strategies on the hardware side to increase the lifetime of smartphones and tablets. First, a better reliability of parts and components, which reduces the probability of failures. Second, a better reparability of the devices enabling to bring devices back to a functional state once a failure has occurred (Cordella et al. 2021; European Commission 2021).

A better reliability (e.g., higher resistance to accidental drops, shocks, scratches, degradation, water and dust resistance, etc.) could lead to less defects in the first place, which would contribute to longer lifetimes. For remaining defects, better technical reparability could lead to more repairs[13] being undertaken instead of purchasing new devices, which is often the default option today (OHA - Obsoleszenz als Herausforderung für Nachhaltigkeit 2019). The ability to repair a product depends on different product-related and support-related criteria. Product-related criteria can be the disassembly depth, fasteners and connectors used, required tools and working environment and necessary skills. Support-related criteria are, among others, diagnostic support and interfaces, the availability of spare parts, types and availability of (repair) information and return models for repair (EN 45554:2020). Each of these criteria is decisive for carrying out a repair operation from a technical point of view and many producers restrict repair by consumers and by independent repair companies through the following measures (Federal Trade Commission 2021; Cordella et al. 2020; European Commission 2021):

- Product design that does not prioritise repair;
- Restriction of spare parts and repair information to manufacturers' repair networks;
- Impeding the use of non-OEM spare parts and independent repair;
- Software locks and firmware updates;
- Intellectual property rights[14] (e.g. copyrights, patents, trade secrets, etc.).

In the past years, design changes could be observed towards more integrated and sealed devices that are less easy to disassemble, require expert skills and the use of specific or proprietary tools within a workshop environment (Berwald et al. 2020).

The availability, accessibility, and convenience of the repair infrastructure are other drivers that influence consumers' decision to repair their products (Houston and Jackson 2016). Currently, the repair offer for mobile phones and tablets is often restricted to services provided directly by the manufacturer or by authorised repair shops that have an exclusive access to support-related criteria (training, diagnostic tools and software, OEM spare parts, repair information, etc.). As a consequence, self-repair is most of the time not possible and independent repair companies are often excluded from the market or have limited access to support-related criteria (Cordella et al. 2020). This can be seen as a case of split incentives where socially desirable actions (repair) are not undertaken by consumers, because market actors have different objectives that are not aligned. This is supported by a recent report by the US Federal Trade Commission (FTC) that analysed repair restrictions. The report concluded that it "is clear that repair restrictions have (…) steered

[13] Providing that such repairs are accessible and affordable (the importance of the costs of repair is referred to within this same section of the report)
[14] IP is part of property right, which is a fundamental right pursuant to Article 17 of the EU Charter of Fundamental Rights.

consumers into manufacturers' repair networks or to replace products before the end of their useful lives. Based on a review of comments submitted and materials presented during the Workshop, there is scant evidence to support manufacturers' justifications for repair restrictions" (Federal Trade Commission 2021). Not only consumers, but also the entire repair as well as the refurbishment business would benefit substantially from better reparability. These are predominantly SMEs situated within the EU (see Annex 5).

Up-to-date software is another important prerequisite for a long lifetime of the devices. Smartphones and tablets run on OS and with firmware. An OS allows the device to run applications and programs. Firmware is software that serves specific purposes related to hardware parts. For a certain period after releasing a new model on the market, manufacturers provide software updates on a regular basis to fix problems and security issues. Updates as well as a lack of updates can bring a device to a limiting state, making it obsolete. Discontinuing security updates can lead to less secure devices and to potential conditions of software obsolescence (e.g. risk of data leaks). Today, the availability of updates depends strongly on the brand and the operating system. While Apple has created its own ecosystem between software and hardware, most of the other manufacturers depend on Google for the operating system (Android). This dependency between hardware and software suppliers can have potential impacts, e.g. when it comes to the availability of (security) updates for a certain amount of time. Apple, through its integrated ecosystem with iOS, provides >5 years of security updates, as from the launch of a product. Other brands that use third-party OS (e.g. Android) offer significantly less time of update support (European Commission 2021). Furthermore, software also plays a crucial role for repair, since the access to diagnostic software and the ability to reset devices is required to perform many repair operations. Repair information and data may also be protected as trade secrets, where the legal requirements apply (Directive 943/2016). Some companies integrate "software locks" that make it impossible to repair a device outside of the manufacturer's authorized service networks, or the use of firmware updates that limit third-party repairs. Manufacturers of devices with embedded software protect their code through intellectual property (e.g. copyright, patents, trade secrets) and may argue that allowing consumers and independent repairers to use that software might lead to expropriation by disclosure of trade secrets and/or royalty-free use of intellectual property. However, in its recent analysis the US Federal Trade Commission concluded that "while it is clear that manufacturers' assertion of intellectual property rights can impede repairs by individuals and independent repair shops, in many instances intellectual property rights do not appear to present an insurmountable obstacle to repair" (Federal Trade Commission 2021).

Another important driver influencing the duration of the active use of a product is consumers' willingness to repair goods instead of replacing them. Users are often prevented from repairing their devices due to the high cost of repair compared to the remaining (perceived) value of the product or the price of a new product (Deloitte 2016). A survey conducted in Germany in 2018 showed that only 26% of the respondents were willing to pay more than 30% of the price of a new smartphone for repairing a one year old broken device (IZT 2018). A different online survey among students showed that the mean willingness-to-pay for a mobile phone repair was around 27% of the price of a new device. The same study also found that the users' willingness-to-pay for repair services declines on average at an annual rate of 6.7% during the use phase of their mobile phone (Sabbaghi and Behdad 2018). An analysis of display and battery replacement costs of 52 smartphones and 15 tablets found that the replacement of a display assembly costs on average 42% of the average purchase price of a new smartphone and 37% of the average purchase price of a new tablet. Battery replacement is usually less expensive and accounts for around 14% of the average purchase price of a new smartphone and 21% of the average purchase price of a new tablet (European Commission 2021). However, this is the minimum price that is charged in case the device does not have any other damages (e.g. cracked screen) that could complicate the replacement of the battery. If the device shows further damages (which is more likely after several years of use), more parts have to be replaced, which makes the repair more expensive. To summarise, currently the high repair costs incentivise users to buy new phones instead of repairing the existing ones.

If the devices find their way to recyclers at the end of their useful life, the usual process is an extraction of the battery (required by the WEEE Directive) and recycling of all remaining parts in a smelter. Integrated batteries are extracted by brute force, breaking the device open and ripping off the battery. The smelters accept all the remainder of the phone or tablet as a high-value fraction. This is due to the fact that precious metals are scattered all over the devices and can be found also in the display, flex printed circuit boards, connectors, etc. For this reason the recycling rate of properly recycled mobile phones and tablets is rather low in terms of a mass-based recycling rate as only some materials are recovered for economic reasons (~15%, see Annex 5). This rate is much lower than foreseen by the WEEE Directive (see 2.1). The recycled materials constitute the majority of the raw material value of a mobile phone or tablet, which is estimated at around 1.11 EUR per phone (Bookhagen et al. 2020). A better reparability usually also enhances recyclability, although the processes are different (non-destructive vs. destructive).

Limited information on sustainability criteria and environmental impacts

To guide effective choice, consumers would need to be fully informed about devices they purchase, including their anticipated lifetimes and environmental impacts. Today, EU consumers are usually not provided with information about a product's lifetime, environmental footprint or any other sustainability criteria such as reliability (e.g. resistance to shocks, falls, scratches, etc.) or reparability at the point of sale (except in France, where a reparability index was introduced in January 2021). If such kind of information were available, consumers could be guided to choose a more environmentally friendly alternative. Some companies provide information on the (dust/water) ingress protection (IP) level of their high performing devices to differentiate themselves from rivals. Others go a step further and claim compliance with military standards, such as the MIL-STD-810 on reliability, i.e. lifetime aspects. However, this US standard allows companies to tailor test methods to fit specific applications, and to select only some of the tests to claim MIL-STD-810 conformity. This flexibility of the standard can make the claim misleading (European Commission 2021).

Battery endurance per full charge is an important performance criterion for users and relevant for purchasing decisions. However, there is no consistent way of measuring the time a device can fulfil a given functionality until a fully charged battery is drained. This is further complicated by the fact that mobile phones and tablets are used for a multitude of functions. Although enhanced battery endurance in cycles is already an important design target and sales argument, better transparency and comparability of related performance has the potential to change the market further towards energy efficient devices. Enhanced battery endurance per cycle also increases overall battery lifetime as the battery needs to be charged less frequently and every charging cycle contributes to battery ageing.

In May 2021, five of Europe's leading mobile operators launched an Eco Rating scheme, which scores the environmental performance of mobile phones based on an assessment of both life cycle and circular economy indicators[15]. The Eco Rating does not cover tablets. It provides guidance in five key areas: durability, reparability, recyclability, climate efficiency and resource efficiency, but does not include any minimum requirements defined as threshold for market entry (a more detailed description of the Eco Rating scheme is given in Annex 9). As of early 2022 the Eco Rating scheme lacks transparent implementation and is not yet prominently depicted on MNOs' sales channels, nor does it cover the full offered product portfolio of the MNOs[16].

2.2.2. Behavioural drivers

Behavioural biases are beliefs or behaviours that can influence the decision-making process and lead to sub-optimal results. While behavioural drivers as such cannot be addressed directly through ecodesign measures, the symptoms can be addressed through regulation.

Social norms and fast value depreciation of fast-moving and fashionable products

Mobile phones and tablets are fashion symbols, which means that not only technical, but also behavioural reasons can be significant drivers for replacement (Cox et al. 2013). Results from a survey in Austria have shown that almost 70% of smartphones are replaced in functioning conditions (Wieser and Tröger 2018). New technological developments and fashion trends can shorten the replacement cycle of devices and the desire to have an up-to-date product is one of the main drivers for replacement for these product groups (Smedley 2016). Fast-moving products also lose their perceived value quickly since they are generally compared to the latest products available on the market. Recent research

[15] https://www.ecoratingdevices.com/

[16] Brand, Robin: Label-Zauberei, Nachhaltigkeitslabel Eco Rating im Check, c't 2022, 5, p. 110-112

shows that smartphones lose around 40-50% of their value after the first 12 months, depending on the brand (Makov et al. 2019).

Smartphones and to a lesser extent also tablets can act as status symbols and comparison with peers, social pressure as well as advertisement can lead to behaviour that favours the purchase of new devices (European Commission 2018). Furthermore, demographic factors, such as age, gender, income, geographic location, and education can play a role. As an example, younger users purchase in general cheaper products and use them for a shorter period of time than elderly consumers (Hennies and Stamminger 2016). Early technology adopters are also more sensitive to trends than conservative consumers and are more likely to replace their devices when new versions enter the market.

Habits and inertia

Habits can hamper innovation and change. If repair was never practiced in a consumer's surrounding, this practice might be unfamiliar. A significant number of mobile phones and tablets are kept in hibernation after their active use lifetime. The functioning part of the devices is usually kept as a back-up solution for occasional needs (temporary solution, for relatives/friends, etc.). The non-functioning part is essentially kept for data safety reasons (data loss/theft) or because of convenience and inertia, since an easy access to the recycling sector is not available or since people forget about the old device due to the small size. According to the special Eurobarometer survey (European Commission 2020c), more than 80% said they would be willing to recycle their old device if there was a nearby recycling point (44%) or if they were sure that there would be no potential data security and privacy risks (41%).

2.2.3. Regulatory drivers

Material efficiency aspects are currently not sufficiently covered by existing regulation (but the situation is evolving)

Existing EU regulations do not sufficiently cover material efficiency aspects, which will be necessary to move towards a circular economy. To change this, the Commission has launched numerous initiatives that are running in parallel at the EU level on the supply and on the demand side. Annex 6 presents and describes the articulation of the two initiatives on the Ecodesign and Energy Labelling of mobile phones and tablets with the other ones under preparation, among which:

- Ecodesign for Sustainable Products Regulation[17]
- Empowering consumers for the green transition[18]
- Circular Electronics Initiative

[17] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12567-Sustainable-products-initiative_en

[18] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12467-Consumer-policy-strengthening-the-role-of-consumers-in-the-green-transition_en

- Promoting sustainability in consumer after-sales and a new consumer right to repair – Right to Repair Initiative
- Common charging solution initiative.

These horizontal initiatives have been taken into account when analysing the policy options.

Varying product legislation in Member States

As highlighted in section 1, some Member States have already started to develop policies targeting the environmental performance of mobile phones, which is a regulatory driver for the need to establish a level playing field at the EU level. More details on specific measures are provided in Annex 5. As mobile phones and tablets are sold on international markets, separate requirements in different Member States could put additional burden on the manufacturers and lead to the fragmentation of the single market.

2.3. Who is affected?

The main stakeholders affected by the problem are manufacturers, retailers, software developers, consumers, repairers, refurbishers (second-hand market) and recyclers.

Most mobile phone and tablet manufacturers are large non-EU companies with production sites mainly in Asia (see Annex 3). They are currently not incentivised to design durable and repairable products or move towards more sustainable business models since their main revenues stem from selling new devices. Moreover, these companies are not required to internalise negative externalities generated throughout the production and distribution process.

Retailers, both online and stationary stores, are in particular affected when sales numbers are concerned. A new opportunity for retailers could be to move into the second-hand market and also to connect with the repair business. Furthermore, increased demand for spare parts could affect specialised retailers.

Smartphones and tablets run on OS, with firmware and applications that require regular updates. Therefore, updates are as important as the physical elements to ensure a longer life of the device and to reduce replacement rates. The availability of updates usually depends on the brand and the OS. Therefore, requirements will particularly affect those suppliers that offer short update and upgrade availabilities.

Consumers lack the necessary information to make sustainable choices at the point of sales. Furthermore, they replace their products prematurely, although they would prefer to have their products repaired, which is also a more cost-effective solution under the right circumstances.

Repairers and refurbishers are mainly EU-based SMEs. They often do not have sufficient access to product-related and support-related elements required for reparability, such as access to tools, spare parts or information. These limitations impact their businesses and the development of a functioning second-hand market that could also benefit consumers.

WEEE recyclers are also affected since they do not receive the products currently stocked by households as an input stream. Most of the European WEEE recyclers are small and medium-sized companies.

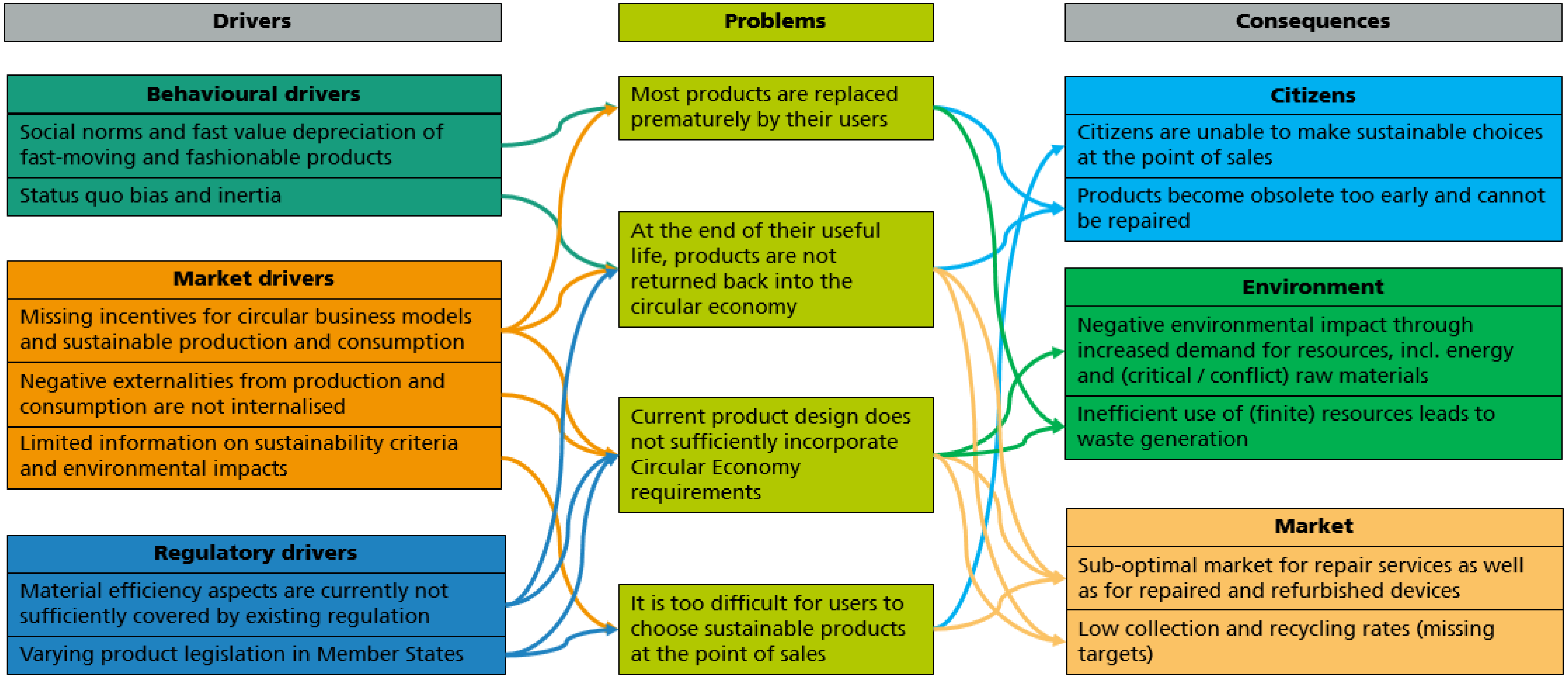


Figure 2: Visualisation of links between problems, drivers and consequences (Problem Tree)

2.4. How will the problem evolve?

Since the market is relatively saturated, the number of mobile phones in active use per person will not increase significantly in the future. The same holds true for tablets, where the stock is even forecasted to drop to around 115 million in 2030 (European Commission 2021). The environmental footprint of manufacturing mobile phones and tablets is likely to increase further as a consequence of better performance: 5G components are adding significantly to the carbon footprint of production due to advanced antenna and chip designs needed for 5G connectivity[19]. Similarly, artificial intelligence features are increasingly embedded in smartphones[20], which requires additional semiconductor area. Payment functionality and embedded SIM[21], along with security features, require additional semiconductor components. The same can be stated for wireless charging circuitries and the still growing number of cameras[22] and related large-area semiconductor based image sensors. Miniaturisation in memory chips is achieved by multilayer processing, which results in significantly more complex semiconductor processing technologies[23]. In general, the mobile phone industry is still the main growth driver of the semiconductor industry. From 2021 until 2026 the mobile phone semiconductor market alone is expected to grow at a CAGR of 7,49%[24]. This growth – as seen in the past – will also result in increasing overall energy consumption and environmental impacts of the industry.

Concerning batteries, the life cycle of lithium-ion batteries in mobile consumer electronics is rather low (500 – 1000 cycles) when compared to most other applications, and there is little momentum, that this will change without policy intervention. Battery capacity is on average constantly growing and subject to further innovation to increase running time on a full charge[25] (see Annex 5 on battery capacity development), but the trend to enable fast charging is currently prevailing[26] and might slow down further possible improvements in battery capacity. The proposal for a battery regulation does not address these issues for this category of batteries (see Annex 6).

Impact of the COVID-19 pandemic

Recent surveys show that the use of smartphones has substantially increased during the COVID-19 pandemic, in particular for social networking, (video) calls for personal and

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[19] Stobbe, Lutz et al. (2020): UTAMO - Umweltbezogene Technikfolgenabschätzung von Mobilfunknetzen und Endgeräten
[20] IEEE: International Roadmap for Devices and Systems (IRDS™), 2021 Edition
[21] Emergen Research: Embedded SIM Market By Solution (Hardware, Connectivity Services), Application (Smartphones, Laptops, Wearables, Connected Cars, Machine to Machine, Others), By End-Use (Energy & Utilities, Automotive, and Others) By Region Forecasts to 2027, October 2020
[22] Yole Développement: Status of the Camera Module Industry, Market and Technology Report 2021
[23] Yole Développement: Status of the Memory Industry, Market and Technology Report 2021
[24] Research and Markets: Mobile Phone Semiconductor Market - Growth, Trends, COVID-19 Impact, and Forecasts (2021 - 2026), April 2021
[25] Allied Market Research: Mobile Battery Market by Type (Lithium-ion Battery, Nickel based, and Others), Application (Smartphone and Non-Smartphone), and Sales Channel (Online and Offline): Global Opportunity Analysis and Industry Forecast, 2021-2030, January 2022
[26] Yole Développement, Status of the Rechargeable Li-ion Battery Industry, Market and Technology Report 2021

professional purposes, online banking and fitness tracking. Many of the respondents also indicated that they will probably keep their intensified use even after the pandemic (Deloitte 2020; Kantar 2020). With higher impacts from manufacturing and use, the problems are therefore likely to intensify in the future without intervention. As an effect of the pandemic the industry currently faces shortages of semiconductors, which partly is a limiting factor for production capacity and thus also reduces sales of devices. As additional semiconductor manufacturing capacity is installed in Asia and elsewhere, this is likely a temporary effect and will not reduce overall stock or sales mid-term.

Current product design does not sufficiently incorporate Circular Economy requirements.

There are currently no indications that manufacturers would change their product design towards more reliable and repairable devices. In fact, there is a risk that some disruptive technologies might lead to a trend towards less durability in the future. As the technology and patent analysis in the preparatory study unveiled (European Commission 2021), numerous activities are on-going to enable larger display sizes by various means, such as foldable and expandable displays. Given the complexity of such design solutions, robustness and reparability of devices are likely to decrease in parallel. As an example, foldable or expandable displays are less scratch resistant than conventional devices. On the software side, software locking or pairing (replacing hardware requiring software activation) can be observed in more and more new devices placed on the market. Specific software is then required to calibrate repaired or replaced components and is typically only available to authorised repairers.

It is too difficult for users to choose sustainable products at the point of sales.

There are signs of an uncoordinated spreading of national and international labelling schemes that can lead to inconsistent and misleading information for consumers, which would not facilitate their choice and therefore not solve the problem. Also manufacturers raised concerns on the fact that it is challenging for the industry to follow different standards and regulations in different national markets as they typically supply an international, frequently a global market.

For France (20% of the EU market) the reparability scoring introduced on 1 January 2021 is expected to influence purchasing behaviour and later on also the lifetime of new devices. The effects will materialise not immediately, but only with the changing reparability practice over time, resulting fewer device replacement purchases. They will also depend on the effectiveness of the repair index and how criteria will be adjusted in the future (e.g. after an ex-post evaluation). Spain is currently assessing the possibility to introduce a similar label, but not necessarily taking over all criteria or weighting factors of the French index. This could lead to different ratings for the same products. The JRC is evaluating the possibility to further develop and possibly implement the scoring system for repair and upgrade of products that was initially prepared in 2019 (European Commission 2019). Annex 8 describes in detail how a reparability score for smartphones and tablets could be built, and this is also modelled as a policy (sub) option. France also announced plans to further develop the reparability index towards a durability index by 2024, integrating criteria related to reliability and upgradability.

The implementation of the Eco Rating by large telecommunication network operators across EU (~25% of the EU markets) in May 2021 could lead to the effect that sustainably conscious consumers will make better informed choices in the future. However, it is not yet clear whether the signals sent to the consumers by this initiative will be consistent with other information provided, e.g. the French repair index.

Most products are replaced prematurely by their users.

Although there are signs of slightly increasing product use lifetimes, which is typical for maturing technologies, upcoming trends might trigger premature replacement of smartphones and tablets. As an example, the transition towards 5G might lead to shorter replacement cycles, although experience with prior technology generations suggests, that this transition stretches over several years. It should be noted that the Directive 2019/771 on the Sale of Goods, introduced a new obligation on sellers to ensure that consumers are provided with updates necessary for the functioning of the goods, including security updates. These new provisions will become applicable as of 1 January 2022 and will allow consumers to use their goods for a longer time. In addition, future measures such as the initiative on the Right to Repair will aim at incentivising sustainable consumer's behaviour when using products, by encouraging for example repairs or the purchase of second-hand goods. These measures will contribute to the extending of the active use of goods. *At the end of their useful life, products are not returned back into the circular economy.*

Without an intervention, the number of hibernating devices will rather increase, as there is no indication, that this trend might be reversed. Most of the material *value* (copper, cobalt, precious metals) coming from end-of-life mobile phones and tablets is already recovered with conventional copper smelters or integrated smelters. However, this represents only a fraction of the total device *mass*, and the current economic model does not incentivise the recovery of other materials, such as plastics, but also aluminium, magnesium, steel, glass and ceramics, which all make up a relevant share to individual product compositions.

3. WHY SHOULD THE EU ACT?

3.1. Legal basis

The legal basis for acting at EU level through the Ecodesign Directive and the Energy Labelling Regulation is Article 114 and Article 194 of the Treaty on European Union and the Treaty on the Functioning of the European Union (TFEU)[27] respectively. Article 114 relates to the establishment and functioning of the internal market, while Article 194 gives, amongst others, the EU the objective to, in the context of the establishment and functioning of the internal market and with regard for the need to preserve and improve the environment, ensure security of energy supply in the Union and promote energy efficiency and energy saving and the development of new and renewable forms of energy.

The Ecodesign Directive and Energy Labelling Regulation are framework acts and both include a built-in proportionality and significance test. For the Ecodesign Directive, Articles 15(1) and 15(2) state that a product shall be covered by an ecodesign or a self-regulation measure if the following conditions are met:

i. the product represents significant volume of sales in the EU, indicatively 200.000 units;
ii. the product has significant environmental impact within the EU;
iii. the product presents a significant potential for improvement without entailing excessive costs, while taking into account:
    - an absence of other relevant Community legislation or failure of market forces to address the issue properly;
    - a wide disparity in environmental performance of products with equivalent functionality.

As set out in more detail in Part 2 of Annex 5, these criteria are fulfilled for the product groups concerned. The sales of all individual product groups concerned vastly exceeded 200.00 in 2021. The potential for improvement stems clearly from the disparity in performance in relation to the relevant aspects described in this impact assessment. The relevant product groups also have significant environmental impacts that take place inside the EU. Those impacts consists of e.g. climate change caused by the associated greenhouse gas emissions, the impacts linked to electricity consumption associated with the use of the products concerned and the impacts linked to managing associated waste streams. For example, in absolute terms, the GHG emissions and energy consumption related to the use phase are higher than for other products covered by other existing ecodesign measures, for which it was concluded that there are significant environmental impacts within the EU[28].

The Energy Labelling Regulation includes similar criteria for products to be covered by an energy label:

[27] Consolidated version of the Treaty on the Functioning of the European Union. OJ C 326, 26.10.2012, p. 47 (TFEU)

[28] See for instance the Commission Regulation (EU) 2019/1784 laying down ecodesign requirements for welding equipment.

- the product group has significant potential for saving energy and where relevant, other resources;
- models with equivalent functionality differ significantly in the relevant performance levels within the product group;

As set out in more detail in Part 2 of Annex 5, these criteria are fulfilled for the product groups concerned. The analysis in this impact assessment (see in particular the section on 'What are the impacts of the policy options?') shows that there is significant potential to improve e.g. the energy efficiency, the durability and reparability of the product groups concerned[29]. Different models show significant difference in performance on those aspects, providing the opportunity for a label to communicate these differences.

3.2. Subsidiarity: Necessity of EU action

Action at EU level would enable consumers to buy a product with lower impact on the environment and would provide end-users with harmonised information no matter in which Member State they purchase their product. This is becoming all the more relevant as the online trade increases. With ecodesign and energy labelling at EU level, sustainable products are promoted in all Member States, creating a larger market and hence greater incentives for the industry to develop them.

As some Member States have started to develop and implement legislation targeting mobile phones, it is essential to ensure a level playing field for manufactures and dealers in terms requirements to be met before placing an appliance on the market and in terms of the information supplied to customers for sale across the EU internal market. For this reason, EU-wide legally binding rules are necessary.

Manufacturers of mobile phones, cordless phones and tablets are worldwide companies placing the same or equivalent product models on the market in different regions of the EU. Consequently, the ecodesign and energy labelling requirements can only be effectively implemented at EU level. As some Member States are enacting measures to target circular economy measures for mobile phones (e.g. France with a reparability index and forthcoming durability index), it would be more effective to have EU rules and also simplify it for the (global) manufacturers to comply with one set of EU rules, rather than with diverging rules in individual Member States.

3.3. Subsidiarity: Added value of EU action

There is clear added value for action at EU level: Without harmonised requirements at EU level, Member States would be incentivised to lay down national requirements in the framework of their environmental and energy policies. This would undermine the free movement of products and increase design, manufacturing and distribution costs. Before the ecodesign and energy label measures were implemented, this was in fact the case for many products. The added value of EU action in the area of the circular economy has

[29] As estimated within this impact assessment, the energy savings related to the use phase that could be associated only to an Energy Label for smartphones and tablets are in the order of 3 TWh/y in 2030. These are similar savings to other already existing Energy Labelling Regulations, such as Regulation 2015/1094 on professional refrigerators.

already been enshrined in the Green Deal, Circular Economy Action Plan and the Ecodesign Working Plans.

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1. General objectives

The general objectives are:

1. Facilitating the free circulation of mobile phones, cordless phones and tablets within the internal market;

2. Fostering the reduction of the environmental footprint of mobile phones, cordless phones and tablets and promoting their material efficiency (i.e. less prone to damage and premature obsolescence);

3. Promoting the energy efficiency of smartphones and tablets as a contribution to the EU's objective to save primary energy consumption by about 35 % by 2030 and to implement the energy efficiency first principle established in the Commission Communication on Energy Union Framework Strategy.

4.2. Specific objectives

The specific objectives of the policy options considered in this impact assessment are to correct the problems identified in the problem definition:

1. Avoiding premature obsolescence of mobile phones, cordless phones and tablets;
2. Contributing towards a circular economy by facilitating repair and increasing durability of these products and key components (e.g. battery and display);
3. Helping consumers making an informed and sustainable choice at the point of sale;
4. Fostering product designs aimed to achieve cost-efficient material and energy savings.

These objectives will drive investments and innovations in a sustainable manner, increase monetary savings for the consumer, contribute to the Energy Union Framework Strategy and the Paris Agreement, contribute to the Circular Economy Action Plan and the Circular Electronics Initiative and support the transition toward a real circular economy (with particular reference to the repair and refurbishment sectors).

The following Figure shows the overall intervention logic linking problems with drivers and the objectives and measures.

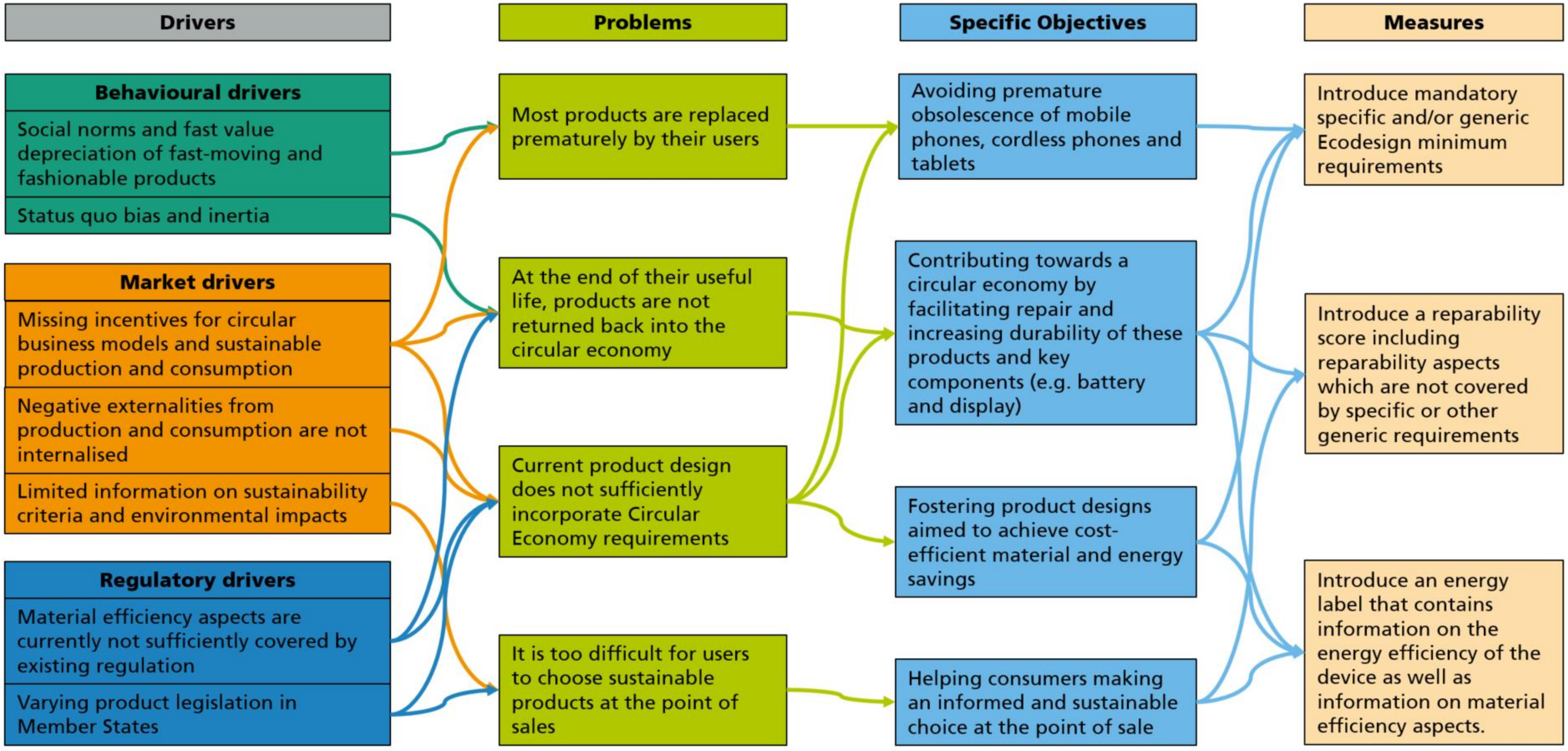

Figure 3: Visualisation of links between drivers, problems, objectives and measures (Intervention Logic)

5. WHAT ARE THE AVAILABLE POLICY OPTIONS?

In order to address the problems and drivers identified in Section 2 and to meet the policy objectives in Section 4, a range of policy options are considered, and compared to a baseline, which represents developments without further EU intervention. Different consultations (as reported under Annex 2) took place to verify the extent to which the policy options could respond to the stakeholders' and the Member States expectations.

Option 1 is the business-as-usual scenario (baseline). Option 2 is a scenario with self-regulation (either a Voluntary Agreement under the sense of the Ecodesign Directive, or other non-legislative initiatives). Option 3 sets ecodesign requirements with variants Options 3.1 to 3.3 are policy options related to Ecodesign requirements and a scoring index on reparability. The sub-options focus on different product scopes and were chosen due to product-specific particularities (design, use, etc.). Option 3.1 focuses on ecodesign requirements for smartphones and tablets. Option 3.2 adds mobile phones other than smartphones and cordless phones to the analysis (distinguishing two levels of ambition without and with extended information requirements on material content, recyclability, upstream greenhouse gas emissions) and Option 3.3 adds a scoring index on reparability for smartphones and tablets. Option 4 is on Energy Label and Option is a combination of Ecodesign and Energy Labelling. For all policy options relating to interventions by the European Commission, i.e. Ecodesign and/or Energy Label regulation, it is assumed, that requirements apply from 2023 onwards.

5.1. What is the baseline from which options are assessed (Option 1)?

Option 1 (baseline scenario) follows the assumption that no new policy measures are introduced at the European level. The smartphone market is split into low-end, mid-range and high-end devices mirroring for past years in particular the placing on the market of larger display sizes 6" and 6.5". Furthermore, the smartphone market sees a trend towards today's high-end technology.[30] On a national level, the French reparability scoring that was introduced on 1st January 2021 is expected to influence purchasing behaviour and later on the lifetime of new devices. France represents around 20% of the EU market. In the "no action" baseline scenario, this national initiative is modelled with the assumption that 50% of the French smartphone and feature phone market (i.e., 10% of the EU markets) will manifest in better reparability and better repair practices. It is further assumed that the effects will materialise not immediately, but over time with changing reparability practices, resulting in longer lifetimes and fewer device replacement purchases. For this reason, the 10% market share is expected to be reached by 2024. Further, in May 2021, several network operators launched an Eco Rating scheme for mobile phones (see section 2.2.1 on market drivers), with the aim to quantify the environmental performance based on an objective assessment of both life cycle and circular economy indicators (detailed description is presented in Annex 9). In case the Eco Rating approach is fully implemented by large telecommunication network operators across EU, it can

[30] https://www.mordorintelligence.com/industry-reports/smartphones-market

be estimated that it would cover roughly 25% of the EU market[31]. Given the findings from the first few months of implementing the Eco Rating scheme it is evident, that the scheme does not yet unveil its full potential as the product portfolios offered by MNOs are not fully covered by scores and as the score is typically presented in a way, which does not allow for direct convenient product comparisons. The baseline has to assume therefore a rather moderate penetration rate of 5% across the EU, which is the share of product purchase decisions likely to be influenced in a positive way.

As highlighted in the problem definition, the environmental footprint of manufacturing mobile phones and tablets is likely to continue the increasing trend due to complex devices and additional functionalities (e.g. 5G, artificial intelligence). The intensive usage pattern of these devices (because of the COVID-19) will probably continue even after the pandemic and therefore the environmental impacts stemming from manufacturing and use are likely to intensify in the future without intervention. There are currently no indications that manufacturers would change their product design towards more reliable and repairable devices and numerous on-going design evolutions (e.g. larger display sizes, folding displays) would negatively impact the robustness and reparability of devices. However, in December 2021 Apple announced the support for self-repair of devices[32], but this announcement refers to individuals experienced with repair, not to users without experience (to whom it is suggested to visit a professional repair provider)[33]. Roll out of this support was announced for the United States and it remains unclear, if and how this might be rolled out on the EU market, unless an Ecodesign Regulation fosters this process. Due to these uncertainties, such potential self-repair initiatives cannot be considered for a robust forecast of the baseline. Finally, at the end of their useful life, products are not returned back into the circular economy and the number of hibernating devices will continue to increase thus a loss of material..

5.2. Option 2: Voluntary Agreement/ Eco Rating scheme

The Ecodesign Directive, in its Article 17, offers the opportunity to manufacturers to sign voluntary agreements, with the commitment to reduce the energy consumption of their products. When appropriate, the Commission formally recognises such agreements and monitors their implementation and abstains from regulatory measures. The industry has so far not proposed any kind of voluntary agreement related to mobile phones and tablets, which is a minimum condition in accordance with Article 17 and Annex VIII of the Directive 2009/125/EC to even consider this option.

The Eco Rating scheme could be considered conceptually close to self-regulation, though – at least for the time being - it would not qualify as a voluntary agreement in the sense of the Ecodesign Directive (Article 17), given that it is proposed by network operators (so not by

[31] Not all European telecommunication providers are involved, potentially not all vendors provide Eco Rating score date.

[32] https://www.apple.com/newsroom/2021/11/apple-announces-self-service-repair/

[33] “Self Service Repair is intended for individual technicians with the knowledge and experience to repair electronic devices. For the vast majority of customers, visiting a professional repair provider with certified technicians who use genuine Apple parts is the safest and most reliable way to get a repair.“

manufacturers), and fails to set both, threshold requirements and a quantified target. It could become an Ecodesign voluntary agreement, if manufacturers of mobile phones and tablets would join and take responsibility for the initiative. The Eco Rating scheme does not implement any minimum requirement, but a comprehensive scoring system covering aspects beyond the scope of Ecodesign requirements.

Under these conditions there is no basis yet to consider a very hypothetical voluntary agreement as a valid policy option. Therefore, this option has to be discarded from further analysis (and therefore its potential effects will not be included in the forthcoming analysis on the impacts of the policy options)

Stakeholders' views on the policy option: The proponents of the Eco Rating scheme, i.e., MNOs, strongly supported a kind of endorsement of Eco Rating through the European Commission, which would, however, neither be compliant with the rules for approving a Voluntary Agreement as an alternative to Ecodesign requirements, nor would the Eco Rating scheme meet the requirements to be directly incorporated in Ecodesign requirements. The views of other stakeholders were not strong, mainly due to the lack of detailed information on the scheme itself.

5.3. Option 3: Ecodesign requirements

Option 3 consists of eco-design requirements. The sub-options (3.1, 3.2a / 3.2b, 3.3) focus on different product scopes and were chosen due to product-specific particularities (design, use, etc.). Option 3.1 focuses on ecodesign requirements for smartphones and tablets[34]. Option 3.2 adds mobile phones other than smartphones and cordless phones to the analysis in two variants: With mainly specific reparability and durability requirements (Option 3.2a) and with additional information requirements on material content, recyclability, upstream emissions and energy aspects (Option 3.2b). Option 3.3 adds a scoring index on reparability for smartphones and tablets. Here, and in the remainder of the text, the tablets meant to be in scope to the proposed policy options are the so called 'slate tablets' (see Annex 9 for the detailed definition). Slate tablets represent the bulk of tablet market, and they share commonalities, in terms of product architecture, usage and behavioural patterns, with the smartphones. They do not have an integrated, physically attached keyboard in their designed configuration, and they are placed on the market with an operating system designed to be used also in smartphones. The supporting analysis for the identification of the products (sub)groups to be covered by the policy options is described in detail at the beginning of Annex 9.

5.3.1. Option 3.1: Ecodesign requirements for smartphones and tablets

[34] Here, and in the remainder of the text, the tablets meant to be in scope to the proposed policy options are the so called 'slate tablets' (see Annex 9 for the detailed definition). Slate tablets represent the bulk of tablet market, and they share commonalities, in terms of product architecture, usage and behavioural patterns, with the smartphones. They do not have an integrated, physically attached keyboard in their designed configuration, and they are placed on the market with an operating system designed to be used also in smartphones.

Ecodesign requirements set specific performance and/or information criteria which manufacturers must meet in order to legally put their products on the EU market[35]. The purpose of these requirements is to remove low-performing products from the EU market. For smartphones and tablets the priority is given to measures addressing:

- Reparability and reusability, including facilitating repair by consumers, but not adversely affecting the durability of devices and in particular:
    - Availability of spare parts
    - Access to repair and maintenance information
    - Maximum delivery time of spare parts
    - Maximum price of spare parts
    - Disassembly requirements
    - Requirements for preparation for reuse
- Reliability and in particular:
    - Resistance to accidental drops
    - Scratch resistance
    - Protection from dust and water
    - Battery endurance in cycles
    - Battery management and fast charging
    - Software updates and operating system support
- Marking of plastic components
- Further information requirements:
    - Recyclability requirements
    - Material content information
    - Upstream greenhouse gas emissions

The ecodesign measures for Option 3.1 were determined on the basis of the analysis of the preparatory study and are detailed in Annex 9, in particular with information related to the nature, rationale and market readiness of each of the above listed requirements. Furthermore, under the same Annex it is also presented how the above requirements represent the 'optimal set' in techno-economic-environmental terms. Finally, Annex 9 also outlines which potential ecodesign requirements have been discarded in the process of the preparatory study and further analyses.

Stakeholders' views on the policy option: Stakeholders were generally supportive. When it comes to the details, the positions of each stakeholder were quite articulated, given the wide breath of the measured proposed. Environmental and consumer NGOs, as well as repairer's organisations, strongly welcomed the proposed requirements, in particular those related to reparability and ease of disassembly. Among the main caveats raised, original equipment manufacturers expressed reservations in particular on the requirements on improved reparability and spare parts availability. Furthermore, some EU member states raised concerns on the testing burden, in particular related to the number of devices to be tested per each product model.

[35] Annex 7 presents an overview on the functioning of the Ecodesign Directive and the Energy Labelling Regulation.

5.3.2. Option 3.2a: Ecodesign requirements regulating also mobile phones other than smartphones and cordless phones; reparability, durability and energy efficiency requirements only

This Option extends the Ecodesign requirements presented under Option 3.1 also to mobile phones other than smartphones (so-called feature phones) and cordless phones, but includes as a less ambitious option only specific requirements on reparability and durability, and related information requirements, plus selected information requirements on e.g. energy efficiency (standby of cordless phones and battery endurance per cycle). The information requirements related to raw materials content, recycled content, recyclability and selected upstream greenhouse gas emissions indicators are not foreseen for feature phones and cordless phones under this sub-option. Details are provided in Annex 9.

Stakeholders' views on the policy option: Specifically with reference to the extension of scope to feature phones and cordless phones, no clear views from stakeholders emerged.

5.3.3. Option 3.2b: Ecodesign requirements regulating also mobile phones other than smartphones and cordless phones; including information requirements on upstream greenhouse gas emissions, material content and recyclability

This Option extends the Ecodesign requirements presented under Option 3.1 also to mobile phones other than smartphones (so-called feature phones) and cordless phones. This option, just as option 3.1, also includes (on top of the reparability and durability requirements) information requirements related to raw materials content, recycled content, recyclability, and selected upstream greenhouse gas emissions indicators for all mobile phones, cordless phones and tablets. Details are provided in Annex 9.

Stakeholders' views on the policy option: There was some criticism raised by Member States regarding the additional information requirements regarding upstream greenhouse gas emissions and means to verify these for non-EU production locations.

5.3.4. Option 3.3: Ecodesign requirements together with a scoring index on reparability

This sub-option is based on Option 3.2b, complementing the minimum Ecodesign requirements with a reparability score for smartphones and tablets only (as explained in Annex 8). The score covers reparability aspects which are not covered by specific or other generic requirements above (such as the required number of disassembly steps for the repair of a priority part), or where these specific requirements allow for enough further distinction in the market to be made transparent through a score (such as type of fasteners and type of repair tools needed). Annex 8 describes in detail how a reparability score for smartphones and tablets could be built. To be noted, that the modelling of the effects associated to the introduction of a reparability score, as in this sub-option, is independent from the 'legal tool' to be used for imposing such a scoring index[36]. Annex 9 describes in detail how to convey to the user the information about the reparability score, based on evidence from recent studies in the field.

Stakeholders' views on the policy option: Specifically with reference to the introduction of the reparability score, stakeholders (in particular EU member states, environmental and consumer NGOs, repairer's organisations) were in general very supportive of this policy (sub) option. Original equipment manufacturers issued mostly technical comments related to the structure/composition of the scoring index.

5.4. Option 4: Energy Label

Option 4 introduces an Energy Label that contains information on the energy efficiency of the device as well as information on material efficiency aspects. The purpose of this option is to ensure that consumers are being provided with the relevant information so that they can make a more informed choice regarding sustainability features when purchasing a new product. Energy efficiency is determined in accordance with an energy efficiency index. The label also contains information related to material efficiency aspects, namely the battery endurance per cycle and in cycles, on repeated free fall reliability and ingress protection (annex 9 presents, inter alia, available evidence from consumer and behavioural studies on the expected positive effect stemming from the quantitative information made available on these parameters). The objective of the energy label is to guide the consumer towards more energy efficient and material efficient devices. The overall spread in the market with respect to such a benchmark performance is a strong argument for an energy label. However, the absolute direct energy consumption per device and year of use is in the range of only around 6-16 kWh/a[37], which is much less than for any other product group regulated under the Energy Efficiency Labelling Regulation (EU) 2017/1369.

This approach is in principle applicable to feature phones, smartphones and tablets. Due to only a moderate spread in energy efficiency among cordless phones in the market, an energy label is not seen as appropriate for these products. Furthermore, the calculation of an Energy Efficiency Index for cordless phones would require a different basis due to limited functionality of cordless phones, different modes (base station constantly connected to the grid) and use patterns. The introduction of an Energy Label for mobile phones and tablets also means a mandatory data provision to the EPREL[38] database, which eases the monitoring of policy

[36] At the time of the drafting of the current impact assessment (Q3 2021), the working hypothesis are either to introduce the reparability scoring as an Ecodesign information requirement, or as part of an Energy Label (with a preference for the latter approach which a) is supported by many stakeholders, among which various EU Member States and b) is the one that could be best communicated and understood by user, as discussed under Annex 9). In any case, the supplier would be obliged to calculate the value of the reparability scoring associated to each specific products model placed on the market, and to publish/display this information as foreseen in the legislative measure.

[37] covering the majority of all mid-range smartphones

[38] European Product Database for Energy Labelling, see at https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/product-database_en

implementation at a later stage. This option does not include the presence, in the energy label, of a scoring index on reparability, which is dealt with separately under option 3.2.

<u>Stakeholders' views on the policy option:</u> Stakeholder comments were quite polarized with regard to this option. On the one side, environmental and consumer NGOs, repairer's organisations and EU member states generally welcomed the proposed energy label. On the other side, original equipment manufacturers were not supportive, claiming that the benefits are not fully clear, given that manufacturers are already highly incentivized to ensure efficient phones for end-user satisfaction[39].

5.5. Option 5: Ecodesign + Energy Label

The following Options 5.1 & 5.2 are policy options combining previous options related to ecodesign requirements, energy labelling and a scoring index on reparability.

5.5.1. Option 5.1: Ecodesign plus Energy Label

Option 5.1 is a combination of Ecodesign and Energy Label, which focuses on smartphones and tablets. It combines Option 3.2 and Option 4.

5.5.2. Option 5.2: Ecodesign requirements together with a scoring index on reparability plus Energy Label

This Option combines the Ecodesign requirements with scoring index on reparability (Option 3.3) and Energy Labelling requirements (Option 4).

A summary of the devices involved under each option is presented inn Table 1.

Table 1: Overview over the analysed Policy Options and their scope

Option	Mobile phones other than smartphones	Smartphones	Tablets	Cordless phones
Option 1 – No action (baseline scenario)	X	X	X	X
Option 2 – Voluntary agreement	X	X		
Option 3.1 – Ecodesign requirements		X	X	
Option 3.2a – Ecodesign requirements (extended scope)	X	X	X	X
Option 3.2b – Ecodesign requirements (extended scope), adding additional information requirements	X	X	X	X

[39] As explained in the next sections, the Commission's view is that an energy label for smartphones and tablets could (as clearly shown by already existing energy labels) have a strong impact on the consumer behaviour and attitude at the purchase. Also, including durability information on the energy label could improve its effectiveness further. The proposed energy label would therefore represent a sound legislative measure to help attaining the specific objectives treated in this impact assessment.

Option 3.3 – Ecodesign requirements, plus reparability scoring	X (without reparability scoring)	X	X	X (without reparability scoring)
Option 4 – Energy Labelling	X	X	X	
Option 5.1 – Ecodesign requirements combined with Energy Labelling	X (without labelling)	X	X	X (without labelling)
Option 5.2 – Ecodesign requirements plus reparability scoring, combined with Energy Labelling	X (without labelling and reparability scoring)	X	X	X (without labelling and reparability scoring)

6. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

This chapter describes for each option the associated economic, environmental and social impacts. The assessment considers the following aspects:

1. **Economic impacts**: business revenue, compliance costs, stranded investments, administrative costs, impacts on SMEs, innovation, R & D, competitiveness and trade, and intellectual property rights;

2. **Environmental impacts**: energy saving, greenhouse gas emission reduction, acidification, materials saving and external societal cost;

3. **Social impacts**: employment, affordability, health, safety and functionality.

Impacts are stated for the year 2030 as by then the policy options will unfold their full potential[40].

All policy options apart from the baseline, i.e. options 3.1, 3.2a, 3.2b, 3.3, 4, 5.1 and 5.2, require EU intervention and are dominated by material efficiency related requirements targeting extended product lifetimes. This is, for example, the case for *Option 4* (Energy Label), where battery endurance affects both, product energy efficiency and longevity; and the reparability score (sub-o*ptions 3.3* and *5.2*). The latter assumes that this transparency in terms of reparability leads consumers to choose more repair-friendly devices and motivates manufacturers to enhance design and/or services towards better reparability. The expected result is a moderate increase in repair rates beyond the level achieved without such a score (i.e., sub-o*ptions 3.1, 3.2a, 3.2b and 5.1*). Such transparency is expected to result in an average lifetime extension of approx. 1 month beyond what is achieved with Ecodesign requirements or Ecodesign and Energy Label only (see Annex 9). Changes in product lifetime and related declining product sales are the main root cause for economic and social impacts detailed below.

Summary tables for each type of impact for smartphones + feature phones + cordless phones, and tablets separately, and at aggregated level (all devices together), can be found in Annex 10.

6.1. ECONOMIC IMPACTS

6.1.1. Direct economic impact for businesses

Manufacturers' Revenue

To comply with ecodesign, energy and reparability requirements, the smartphones, feature phones, cordless phones and tablet manufacturers will need to make investments in turn increasing production costs. If this translates into a higher price for the product, it will affect both business revenue and consumer expenditure, as manufacturers are expected to pass on

[40] Any forecast beyond 2030 for such a product group characterised by short innovation cycles would be very speculative and subject to major uncertainties.

increased costs to consumers. However, higher prices do not always imply higher business revenue as the longer product lifespan achieved through ecodesign, energy efficiency and reparability requirements result in a decrease of unit sales that counteracts the effect of higher prices for manufacturers. This mainly concerns non-EU business revenue since EU manufacturers have a negligible market share. Given the degree of competition among non-EU manufacturers (as shown in more detail in Annex 5, there are a number of OEMs from various countries - mainly US, South Korea and China - in direct competition), it is considered unlikely that they would try to counterbalance reductions in revenue due to lower unit sales by increasing their prices.

Option 1 (No action) would imply a slight increase (+4%) for 2030 and compared to today in business revenue from *smartphones, feature phones and cordless phones* assuming no changes in consumer behaviour neither in prices. All these devices present a negative trend in sales, except for high-end smartphones, which are also the ones with the highest price. This last effect is greater and explains why business revenue is expected to increase under no-action scenario. For *tablets*, a future negative but slight trend (-3%) is observed due basically to the lower interest and greater durability of these devices compared to smartphones that results in lower sales, and thus in lower business revenue.

Some options including Ecodesign requirements (i.e. *Option 3.1* and *Option 5.1*) would imply a significant reduction in business revenue in 2030 (when compared to the other options) even if the estimated price increase took place, both for phones and tablets. It will be about 1,150 million Euro[41] (16%) of reduction in revenue for *tablets* under these options compared with "no action" and a reduction of EUR 18,300 million (24%) for the aggregate of *smartphones, feature phones and cordless phones*.

Sub-option 3.2b, although it includes more devices subjected to ecodesign requirements, will result in a similar reduction as *Option 3.1*, EUR 18,400 million less (24%) compared to no-action for *smartphones, feature phones and cordless phones*. The same reduction is achieved if these devices are subjected to less ecodesign requirements, i.e. *sub-option 3.2a*, with EUR 18,600 million less (24%). Business revenue for *tablets* under *sub-option 3.2a* will reduce 15% (EUR 1,200 million).

There will be similar outcomes for sub-options including a reparability score and considering the aggregated of *smartphones, feature phones and cordless phones*, resulting in a revenue reduction of EUR 19,200 million (25%) under *sub-option 3.3 and* of EUR 19,800 million (26%) for *sub-option 5.2.* Figures for *tablets* under these sub-options are EUR 1,200 million in both cases.

41 This comparison is expressed in nominal terms. Henceforth, 2030 prices will be presented under its nominal value.

The option of establishing only an Energy Label (*Option 4*) could also imply a reduction in revenues but much lower than the Ecodesign options, it is EUR 2,300 million less (3%) than in the no-action scenario. The main reason is that with the Energy Label, as lifetime does not improve as much as with Ecodesign, the number of devices sold will not change by the same amount. For *tablets*, the Energy Label (*Option 4*) would lower business revenue by EUR 144 million (2%).

6.1.2. Compliance Cost

Impacts on OEMs

The compliance costs for implementing Ecodesign options (i.e. *Options 3.1, 3.2a, 3.2b, 3.3, 5.1 and 5.2*) on average are very moderate. For models sold in large numbers this cost increase will be even less relevant, considering economies of scale. For models where fewer units are sold, the redesign costs might become an issue. In any case, as most of the OEMs are located in the U.S. and Asia, it will affect mainly non-EU OEMs.

Verifying legal compliance will require substantial product tests, involving laboratory test costs and costs for test units. As some of the reliability requirements need to be based on a sound statistical basis (repeated free fall tests, battery lifetime tests), approximately 20 units of a model need to be tested. It is however right now already established practice among OEMs to test a substantial number of pre-series products against reliability criteria. Hence, rather some adaptations of the test setting might be needed to cover test conditions stipulated by Ecodesign and Energy Label requirements.

Spare part availability in general might become a risk for OEMs as they have to plan how many spare parts might be required over a given period. As these parts are typically sourced from suppliers, OEMs depend on the continued availability of spare parts or have to stock spare parts.

Effects of design requirements on smartphones and tablets vary. Some of them, such as adding water and dust resistance or incorporating an operating system support, imply costs to add to the purchase price (EUR 3 and EUR 2 per unit, respectively). Others, such as simplifying exchange of broken parts, have no effect on costs or imply savings.

Although several of the proposed measures (e.g. increased inventory requirements[42]) are related to additional costs, savings from other design requirements and the effect of economies of scale result in a weakly marginal price increase on average. It must be added that some design options are already implemented in devices (especially for mid-range and high-end smartphones) so this implies less additional costs.

Other compliance costs may include establishing production and supply chain changes to fulfil minimum requirements (including testing facilities and training); need for personnel to design new, compliant products and higher personnel activity dedicated to support of professional

[42] for a detailled analysis see Annex 10, p. 217

transitions from activities reduced by these requirements towards those favoured by them (specifically: maintenance, repair/upgrade, refurbishing, remanufacturing). Training staff to become acquainted with the system is a one-time investment and although there is not specific data, it is not considered significant.

6.1.3. Stranded Investments

In the case of *smartphones* and *tablets*, stranded investments may arise in third countries as the production in the EU is minor. It mainly refers to new production facilities that have been installed recently and they may not be as profitable as expected because of the future reduction on sales if some of these options are introduced (specifically those including Ecodesign requirements). In the case the already established OEMs decide to re-convert their machineries, this will imply new costs, proportional to the current efficiency level of industrial sector in these countries. However, how production firms react will determine the final effect, i.e. if they decide to shift supply to other non-EU countries (less regulated in Ecodesign, efficiency and reparability terms) or put their focus on other products, they could redirect the negative effect.

6.1.4. Administrative burden

Administrative burden for economic operators

The following burdens concern all proposed options, in comparison with the baseline scenario. The administrative burden for business is related to the price of testing increased by these new requirements. Tests are applied by OEMs, so they mainly concern non-EU countries. Another administrative burden may include the personnel cost to carry out testing and verification, and costs of product registration database, (mainly when Energy label is applied). Training staff is a one-time investment and not considered significant. Equally, and related to the registration database, uploading manufacturer information and obtaining the manufacturer code is considered not significant. However, uploading product specific information implies selecting appropriate information, formatting, and actually uploading the information, implying a higher cost. Based on studies for other electronic devices (electronic displays), the product registration database implies costs of about EUR 60/model. Several hundred mobile phone models are launched every year on the EU market, and a few hundred tablet and cordless phone models. Some brands launch a few dozen variants each year whereas some small players do not even launch a new model every year. Total costs relating to the registration of new models would be very limited (a few 10 000 EUR for all manufacturers together).

Measures such as including a reparability score and/or an Energy Label on the packaging or on the device itself (*Option 4 and sub-options 5.1, 3.3 and 5.2*) also involve administrative and logistics costs for OEMs, e.g., providing labels. For suppliers, the estimated cost to print a label is about EUR 0.3 per device[43]. For the total of *smartphones, feature phones and cordless phones* sold in 2030, this additional cost will be EUR 36 million (*sub-options 3.3 and 5.2*), EUR 37 million (*sub-option 5.1*) and EUR 46 million (Option 4) (See Annex 4 about

[43] Based on estimations for TV display's Impact Assessment (European Commission, 2019).

methodology). Comparing the number of mobile phones produced in the EU with those imported from outside shows that only 3% of these costs will be borne by EU manufacturers with the remaining 97% corresponding to non-EU manufacturers[44]. Having made this distinction, the related costs under each option are: sub-options 3.3 and 5.2, EUR 1.2 million for EU manufacturers and EUR 34.8 million for non-EU manufactures; sub-option 5.1, EUR 1.3 million for EU manufacturers and EUR 35.7 million for foreign ones; and Option 4, EUR 1.6 million and EUR 44.4 million, respectively.

Similarly, for tablets, given that sales will be greater under Option 4, this will present the highest cost in labels (EUR 7 million). The other options that require a label (i.e. sub-options 3.3, 5.1 and 5.2) will imply additional EUR 6 million. Like for phones there are only a few rather small tablet manufacturers in the EU. As such, the distribution of labelling costs among EU and non-EU manufactures will also be similar (3% and 97%, respectively). Therefore, Option 4 would imply EUR 0.2 million for EU manufacturers and EUR 6.8 million for non-EU ones, while the other options will cost EU manufacturers EUR 0.2 million and foreign ones EUR 5.8 million.

Energy Label and Reparability score policy options (*Option 4 and sub-option 5.1, 3.3 and 5.2*) also involve administrative and logistics costs for *retailers.* Costs are related to presenting the labels of products on stock/display at the point of sales and/or on online platforms. This means, in practical terms, that retailers must take out the printed label (provided by the supplier) from the product box, and put it visibly close to the product (at the point of sale). Thus, it means that this operation has to be performed only for the product models exposed in the store (or virtually, in the online shop). Given the small number of products for which they need to do this physical operation, the final effect on retailers is expected to be marginal.

Administrative burden for citizens

There is no administrative burden/cost for citizens.

Administrative costs for the European Commission

The main administrative costs for the European Commission will be from establishing minimum requirements, review of these requirements regularly, and mandating the development of test standards. Clear targets and guidelines on Ecodesign requirements and criteria to elaborate the Reparability index and Energy label will also have an administrative burden.

Administrative burden for Member States

The form of the legislation proposed under all the options foreseeing regulatory approaches (3.1, 3.2a, 3.2b, 3.3, 4, 5.1, 5.2) is respectively an implementing Regulation (in the case of

[44] These percentages are estimated based on 2019 PRODCOM data for the product categories under NACE code 26302200-Telephones for cellular networks. The total production linked to EU sales is understood as the sum of imports from non-EU countries (170 million mobile phones) and EU production (6 million phones).

Ecodesign) and a delegated Regulation (in the case of Energy Labelling), both directly applicable in all Member States. This ensures that there would be no costs for national administrations linked to transposition. Furthermore, costs that may arise for Member States include the costs of establishing surveillance systems (more detailed in Annex 10), setting up the enforcement processes (including training), government expenditures for conformity review (circularity aspects, premature obsolescence) and monitoring compliance with the requirements.

6.1.5. Impacts on SMEs

There is an opportunity for companies in the EU market to further develop and capture the **repair and refurbishment market**, where significant growth has recently been seen[45]. As most of the companies in these markets are SMEs, it could represent a significant potential positive economic impact for the sector, not only regarding existing companies that would grow but also new ones that would emerge.

While a positive impact on SMEs in the repair/maintenance sector is expected, the opposite is observed for **manufacturers** of all considered devices: telephones for cellular networks or for other wireless networks (NACE 26302200), line telephone sets with cordless handsets (NACE 26302100) and laptop PCs and palm-top organizers (NACE 26201100). However, the main stakeholders affected will be non-EU manufacturers which own almost the entire production market share. For smartphones, feature phones and cordless phones, the largest negative impacts would be from the Ecodesign options, especially the one including a repair index plus Energy Label (i.e. *sub-option 5.2*) compared to the baseline. The lowest negative effect in terms of reduction of sales and of business revenues is expected under *Option 4*. **These conclusions are based on estimations that establish a relationship between employment and sales.** However, this only allows to show the trend of this sector, because other factors must be considered.

A positive impact on **third party developers of software applications** running on smartphones and tablets could be expected, as the requirements on OS updates are likely to lead to a less fragmented landscape of OS versions in use, thus potentially simplifying mainentance and support of software applications, which are supposed to be compatible with OS versions running on end devices. The business model of application developers, being SMEs in their vast majority, could thus benefit from the OS update requirements.

SMEs in the EU **retail** sector could be negatively affected because of the expected sales reduction under all considered options. However, it is difficult to establish the retail path with accuracy, because of many factors that can be considered and not all of them affect in the same way (for example, retailers can shift their supply to other devices with a better future projection, in term of sales).

[45] For example, in the case of smartphones while the market of new phones is saturated, the market in refurbished phone is showing strong growth https://www.lemonde.fr/economie/article/2019/02/24/smartphones-le-boom-de-l-occasion_5427668_3234.html

6.1.6. Competitiveness, trade and investment flows

Functioning of the internal market

All options considered, i.e. *Option 4, and sub-options 3.1, 3.2a, 3.2b, 3.3, 5.1* and *5.2, due to its compulsory nature* will help in establishing a level playing field in the EU market, given that currently some MS have requirements (e.g., France[46], Germany[47], Sweden[48]), while others do not, resulting in diverging requirements for businesses to comply with for the same products. Common requirements will result in benefits, especially for those including Ecodesign *(sub-option 3.1, 3.2a, 3.2b, 3.3, 5.1* and *5.2)*, as we have already seen in the case of the Ecodesign Directive[49]. Increased reuse, longer lifetimes, reparability, availability of high-quality recycled material, etc. will help in increasing the stock life, availability of secondary high quality raw material and thus reducing the import dependency of the EU. In the long run, EU businesses will benefit from ecodesigned products[50], especially:

- Spare part and toolkit providers that enter the market in larger numbers if repairs are significantly simplified.
- Reuse/Refurbishment/Re-commerce businesses, resulting in greater availability and lower prices of used devices.
- Repair/maintenance sector will be able to increase its capacity to offer its service (more adapted design of devices to be repaired) and this will be more demanded by consumers[13].
- Recyclers, benefitting from greater availability of units for recycling (as an effect of the requirements on preparation for reuse) and changes in recycling processes triggered by design changes.

Others, such as equipment, tools, semiconductors and display technology suppliers could be negatively affected if sales decrease and reduce the demand for key components. However,

[46] French law against waste and for a circular economy https://www.ecologie.gouv.fr/loi-anti-gaspillage and reparability index

[47] Circular Economy Act 2020 https://www.bmu.de/en/law/circular-economy-and-safeguard-the-environmentally-compatible-management-of-waste/

[48] Swedish strategy for circular economy accelerates the transition to sustainability 2020 https://www.government.se/4ad42c/contentassets/d5ab250cf59a47b38feb8239eca1f6ab/circular-economy--strategy-for-the-transition-in-sweden

[49] *"the circular economy requirements embodied in the Ecodesign Regulations are typically identified as the most effective solutions – in regulatory terms – to 'market failures', i.e., observed deviations from perfectly competitive market behaviour"* in Bukarica and Tomši´c (2017) Energy efficiency policy evaluation by moving from techno-economic towards whole society perspective on energy efficiency market. Ren. and Sust. Energy Rev.

[50] ADEME (2017) Analyse des bénéfices économiques et financiers de l'éco-conception pour les entreprises. This study covering 10 companies from five different sectors (food, IT, sport, building, pharmaceutical, and hitech) estimated several economic and financial returns generated by the implementation of ecodesign approaches in companies: significant increase in turnover (up to a factor of 5 for the most marked case, + 7 to 18% in median values); a tangible reduction in production costs (up to -20% in the most pronounced case); and strengthens the commitment of employees and improve the internal functioning of the company. https://www.ademe.fr/analyse-benefices-economiques-financiers-leco-conception-entreprises

those providers supply different industries and they could also switch supply to other sectors (e.g., computers or Internet of Things).

6.1.7. Indirect economic impacts for businesses

As shown in the previous subsections, the compliance costs for OEMs are expected to be in general moderate, since the production of these devices is linked to economies of scale, and new design costs will be shared among a high number of products. Moreover, not all new requirements imply higher production costs. For example, there are some features such as the pre-installed battery management software that won't have any effect since most devices already have it. Based on these considerations, negative reactions from third countries OEMs, such as 'versioning'[51] or retaliation, are not expected. The first signals from the market are rather in the opposite direction:

- As already described in the policy options section, a reparability scoring was introduced in France on 1st January 2021. To date, these has been no evidence from the French market of OEMs having to restrict their product range because of this obligation. Rather, there is anecdotal evidence on the fact that some OEMs are improving their service strategy to gain a better scoring.
- The recent initiative from a major OEM[32] on the support for self-repair of devices can be regarded as a 'self-regulatory reply' to the ongoing preparatory work for the potential Ecodesign requirements analysed in this impact assessment. Again here, a (potential) regulatory solution fosters a transition of the market towards more sustainable products.
- A further indication that third countries will deal in a constructive manner with this type of policy initiatives is the fact that in China policy makers and OEMs consider a complementary carbon footprinting scheme for batteries to comply with requirements under the upcoming EU Batteries Regulation[52], which features some similarities with the Ecodesign Regulation.

Innovation and Research

Options that involve an Energy Label and a Reparability index are largely based on information requirements and scoring systems. OEMs are expected to respond with their product designs, leaving room for innovations to reach high scoring values. Ecodesign options would demand investment on performance features in order to achieve the requirements in terms of durability, energy use, battery life, etc.

As most manufacturers are located in the U.S. and Asia, setting ambitious mandatory minimum Ecodesign requirements combined with a stimulating Energy Label scheme will, thus,

[51] i.e. the fact that, due to the excessive stringency of the Ecodesign requirements, OEMs would find convenient to only adapt some of their products (rather than keeping the whole market range, as today) to be compliant for the EU market. This would results in a limited choice of products for EU users.

[52] https://www.next-mobility.de/eu-batterie-regeln-wie-china-einen-ausschluss-vom-europaeischen-e-auto-markt-verhindern-will-a-1102334/

positively influence innovation in third countries. Still, innovation could be promoted through the supply chain of market players (including EU ones), in particular in the repair and refurbishment sectors. As it has been seen from previous Ecodesign and Energy Labelling measures[53], these options are expected to have a positive impact on the deployment and diffusion of innovations.

Especially for options including a reparability index (i.e. *sub-options 3.3* and *5.2*), education is also positively influenced, since promoting more repairable devices encourages people to acquire new skills. Moreover, this knowledge is expanded by means of communities such as that one constituted by Youtubers that help others get the most out of their devices by answering questions or giving advice on repairs. This could imply a cultural shift to convince people to fix it rather than throwing it away.

Intellectual property rights

Intellectual property rights of manufacturers may be affected to the extent that the proposed measures impose the availability of repair information and spare parts. Allowing the use of instructions for software and firmware[54] might draw some criticism, given that software plays a crucial role for repair and manufacturers protect their code through intellectual property. In this context, manufacturers might need to disclose trade secrets[55] and/or accept the use of their software royalty-free. Appropriate formulation of the (Ecodesign) requirement may be necessary to strike a balance between the need to oblige OEMs *to make available to professional repairers software tools, firmware and similar auxiliary means required for full functionality of the spare part and device after repair* and any potential impact on their IP.

Concerning, more in general, the issue of spare parts, the EU has launched a reform of its design legislation (described in Annex 6), which aims at liberalising the spare parts aftermarket.

6.1.8. Economic impact for citizens

The analysis in the preparatory study (European Commission 2021) only showed a minor product price effect for any analysed policy options compared to the baseline. Any such price increase is compensated by the product lifetime extension and thus results in less frequent acquisition of electronic devices, enhanced by an expected more conscious consumer behaviour. This means that, in general, from a product life cycle perspective, consumer expenditure in EU countries will decrease with the analysed policy options (see Section 6.3.2).

It should be noted that not all Ecodesign requirements imply a higher final cost for consumers. It may be that some of them slightly increase the acquisition price, but they could result in

[53] https://ec.europa.eu/energy/sites/ener/files/documents/201405_ieel_product_innovation.pdf
[54] In particular as an effect of the requirement to make available software tools, firmware and similar auxiliary means required for full functionality of the spare part and device after repair (see Annex 9 for more information)
[55] Directive (EU) 2016/943 on the protection of undisclosed know-how and business information (trade secrets) against their unlawful acquisition, use and disclosure and Article 39 of the WTO TRIPs Agreement provides for protection for undisclosed information, including trade secrets.

savings in future repairs, e.g. battery joining techniques or a battery removable without tools imply a reduction in battery repair cost by 5-30€[56]. Reparability scoring also implies this future saving, while Energy label reflects lower energy consumption.

Options providing information about energy efficiency of devices (i.e. *Option 4* and s*ub-option 5.1*) can make a significant contribution to energy savings by consumers and thus reduce energy bills (see section 6.2 and Annex 10 for energy consumption estimates and assuming a constant energy price) if consumers decide to switch from energy-intensive devices to more efficient ones. This change in demand will promote innovation and investments for their production.

Consumers will also benefit from greater quality of devices, given the continuous tests they have to pass in order to ensure they comply with all ecodesign requirements and achieve a good score on the Energy label and/or regarding reparability.

6.1.9. Impact on third countries

The implementation of Ecodesign options with or without an Energy label and/or a Reparability scoring in the EU will put in place new requirements for mobile phones and tablets, which are mostly manufactured in production sites outside the EU. A sales reduction is expected (that means lower EU imports) given the extended life time of new devices but, in order to maintain their share as suppliers of European countries, manufacturers from third countries will have to react quickly offering more efficient and ‘ecodesigned’ products. The nature of the economic impacts, and their repartition between EU and non-EU businesses, is linked to the intrinsical ‘circularity’ of the initiative. Shifting from a traditionally linear ‘take-make-discard’ economic model to a more circular one, where repair and recycling activities gradually become more prominent and resources can be saved, is among the objectives of the initiatives of this impact assessment. This shift would obviously imply that:

- on the one side, entities such as the (typically non-EU) original manufacturers would see the effects on their business described above, in particular the expected sales reduction;
- on the other side, entities belonging to the repair sector (typically local SMEs) are expected to strongly benefit from the initiatives, in particular thanks to the proposed Ecodesign requirements on reparability and ease of disassembly.

6.2. ENVIRONMENTAL IMPACTS

The overall environmental impact of this product group, as identified in the preparatory study, is below 1% of the EU total emissions for most of the environmental indicators, which may seem small but in absolute terms is significant. Most of the environmental impacts relate to EU indirect impacts in upstream supply chains. The following subsections will present the global impact on environmental indicators under the different policy options. As almost all of the supply chain is located outside EU, impacts related to production can be considered as originating in their majority outside the EU. The distribution phase partly can be allocated to

[56] Figures from European Commission Preparatory Study (2021)

EU, partly to non-EU countries. Finally, changes in use phase and end-of-life related impacts clearly can be attributed to EU. However, the overall environmental impacts affect all countries (EU included) given the global nature of most of them, as explained under Annex 5. The improvement potential through policy intervention is significant, as shown in the next subsections.

6.2.1. Energy savings

There are savings under all options in comparison with no action. In all cases, savings are driven by technological improvements and extension of the use lifetime of devices.

In 2020, the no action-scenario predicts 115 PJ energy consumption from *smartphone*s (103 PJ), *feature phones* (6 PJ) and *cordless phones* (6.5 PJ). In 2030, the no action scenario is estimated to result in a reduction of 1PJ in energy consumption for both feature and cordless phones, while overall, smartphones' energy consumption remains the same compared to current values. The Ecodesign and energy label scenario (sub-o*ption 5.1*) and Ecodesign and repair index (*sub-option 3.3*) give 40 PJ savings in 2030 with respect to the no-action scenario. Ecodesign applied only to smartphones (sub-o*ption 3.1*) saves 37 PJ. Energy consumption also declines notably with ecodesign *sub-option 3.2a and 3.2b* (36 PJ and 39 PJ, respectively). The biggest reduction will be achieved under *sub-option 5.2* (42 PJ), while the savings attributed to theEnergy Label scenario (*Option 4*) are in the order of 10 PJ in 2030. In relative terms, this is certainly less than the impact from the Ecodesign option. However, in absolute terms it still qualifies as significant (see Annex 5). As for smartphones, feature phones and cordless phones, *tablet* total energy consumption decreases significantly with options involving ecodesign requirements. In 2020, the no action-scenario predicts 27 PJ energy consumption. In 2030, the no action scenario is estimated to result in 1 PJ less energy consumption while the number of sales and stock of tablets decreases. The Energy Label scenario (*Option 4*) saves 3 PJ in 2030 compared the no-action scenario. The savings potential of sub-*option 3.1* is 7 PJ by 2030, being 8 PJ under s*ub-option 3.3, 5.1* and *5.2*. The less ambitious ecodesign sub-option, i.e. *sub-option 3.2a, allows* 7 PJ of savings for tablets.

6.2.2. GHG emissions and acidification

Trends for greenhouse gas (GHG) emissions are similar to energy consumption trends.

For *smartphones, feature phones and cordless phones* under no action, **GHG emissions** in 2020 are estimated at 7.3 million tCO2 eq.: 6.6 million t CO_2 eq. (reducing to 6.5 million t CO_2 eq. in 2030) for smartphones, 0.3 million t CO_2 eq. for feature phones (0.3 also in 2030) and 0.4 million t CO_2 eq. for cordless phones (declining to 0.3 million t CO_2 eq. in 2030). With sub-o*ption 3.1* (Ecodesign requirements), sub-o*ption 5.1* (Ecodesign requirements and Energy Label) as well as *sub-options* including a repair index (i.e. *3.3* and *5.2*) Greenhouse Gas emissions drop significantly over time. For these scenarios, the related emissions are from 2.7 (for *Option 3.1*) to 3.0 million t CO_2 eq. (for *Option 5.2*) lower in 2030 than with "no action" (over 40% reduction). Ecodesign *sub-options 3.2a and 3.2b* also reduce Greenhouse Gas emissions: 39% and 40% of reduction, respectively. A lower reduction is expected under *Option 4* (4%).

About **acidification related to** *smartphones, feature phones and cordless phones* sold in EU, sub-o*ptions 3.1* (Ecodesign requirements), *5.1* (Ecodesign requirements and Energy Label) and *sub-options 3.3* and *5.2* (with repair index) result in significant reductions in SO_2 and other emissions contributing to acidification. These emissions and related reductions mainly stem from production impacts outside the EU, thus having a regional effect outside the EU, and only to a smaller extend from reductions in use energy consumption in the EU (*Options 4*, *5.1*, and *5.2*). Roughly 20 kt SO_2 eq. less in 2030 is the calculated effect of sub-*options 3.1, 5.1* and *3.3* for the year 2030. Option 5.2 results in the reduction of 22 kt SO_2 eq. A similarly high savings potential is achieved from 2027 onwards in these scenarios, also for *sub-options 3.2a* and *3.2b*. *Option 4* (Energy Label) results in less emissions reduction (3 kt SO_2). These emissions are mainly due to electricity use along the life cycle phases.

Similar trends are identified for *tablets*. For sub-*options 3.1* (Ecodesign requirements) and *5.1* (Ecodesign requirements plus Energy Label) and the respective sub-options including a scoring on reparability (i.e. sub-*option 3.3* and *5.2*) **Greenhouse Gas emissions** drop significantly from 2023 onwards. The same for the less ambitious ecodesign option, i.e *sub-option 3.2a*. For all these scenarios, the related emissions are 0.5 million t CO_2 eq. lower in 2030 than with “no action”. Compared to this savings potential only an Energy Label (i.e., *Option 4*) yields a significantly lower savings potential, but still 0.1 million t CO_2 eq.

Acidification under *policies 3.1* (Ecodesign requirements), *5.1* (Ecodesign requirements and Energy Label) and the other *sub-options* (i.e. *3.3* and *5.2*) result in significant reductions in SO_2 and other emissions contributing to acidification, 2.8 kt SO_2 eq. less in 2030. A reduction of 2.6 kt SO_2 eq is expected under *sub-option 3.2a*. A similarly high savings potential is achieved from 2027 onwards in these scenarios. *Option 4* (Energy Label) results in the least emission reductions (0.8 kt SO_2 eq.).

6.2.3. Circular economy perspective: material consumption

Total **material consumption** from which *smartphones, feature phones and cordless phones*, accessories and packaging sold in 2030 are made is calculated to be roughly 86,500 t with *Option 1* (of which 75,600 t smartphones, 6,300 t feature phones and 4,600 t cordless phones). This value is considerably reduced along with the declining sales of all devices with sub-o*ption 3.1* (Ecodesign requirements) down to roughly 58,700 t (32% reduction), and sub-option 5.1 (Ecodesign requirements plus Energy Label), down to 54,700 t (37% reduction). Total material consumption with *sub-option 3.2a* reduces by 31%, to 59,000 tons and *sub-option 3.2b* reduces by 36%, to roughly 55,600 tons. With *Option 4*, material consumption reduces by 1%. As almost all materials used in these devices are mined and processed outside the EU, the reduced material consumption means accordingly less mining and processing outside the EU. Better recyclability and incentives to return used devices under *Options 3.1, 3.2a, 3.2b, 5.1* and *5.2* will secure resources for the EU economy. The consumption of **Critical Raw Materials** also decreases along with the declining sales.

In the “no action” scenario the overall amount of material used for *tablets*, accessories and packaging made in 2030 is calculated to be roughly 30,400 t. This value is reduced with sub-

options 3.1 (Ecodesign requirements), *sub-options 3.2a* and *5.1* (Ecodesign requirements and Energy Label) down to roughly 22,000 t. The consumption of **Critical Raw Materials**, provided that the composition of tablets does not change fundamentally, is also reduced along with the declining sales of devices.

Full quantitative information for *sub-options 3.3* and *5.2* are not available, but given they are built on *sub-options 3.2b* and *5.1*, expected figures about material consumption will be at least the same or even lower since a reparability scoring supposes an additional impact. The environmental benefits of including reparability scoring would be significant: it avoids early failures allowing products to have a longer lifetime and thus, be less frequently replaced. This enhances their potential for circularity (i.e., re-sale and reuse) and reduces environmental impacts related to the production, transport, and disposal of products.

6.2.4. External societal costs

For *smartphones, feature phones and cordless phones*, maintaining the no-action scenario (*Option 1*) will result in societal costs because of externalities. Implementing any of the proposed options would result in positive effects. With *Option 4* (Energy Label) external annual costs will be reduced by about EUR 120 million compared to the baseline scenario. A major reduction in external annual costs is achieved with sub-o*ption 3.1* (Ecodesign requirements), *sub-options 3.2a and 3.2b* (Extended ecodesign options under different requirements), sub-o*ption 5.1* (Ecodesign requirements and Energy Label) and *sub-options* including a repair index (option *3.3* and *5.2).* Significant reductions are achieved under sub-o*ption 3.1*, 3.2b, *5.1*, *3.3* and *5.2* by almost EUR 900 million less in 2030 (the greatest reduction is for *sub-option 5.2*). *Sub-option 3.2a* is not as ambitious, with a reduction of EUR 730 million compared to no-action. More detailed information is found in Annex 10.

The social annual external costs of *tablets* will be slightly lower in 2030 under *Option 1* compared to today, but greater results in terms of reduction will be achieved by implementing sub-*options 3.1* (Ecodesign requirements) and *5.1* (Ecodesign requirements and Energy Label) and sub-options including a repair index (*options 3.3* and *5.2*). These options reduce societal costs by almost EUR 150 million in 2030 compared to the "no action" scenario. A lower but relevant result is obtained under *sub-option 3.2a*, with EUR 110 million less. With O*ption 4* (Energy Label), external damages will only be reduced by EUR 33 million in 2030.

6.3. SOCIAL IMPACTS

6.3.1. Employment

The biggest effects on employment are related to the numbers involved in the EU **repair and maintenance** sector.

For *smartphones*, *feature phones and cordless phones* with **Method A** (see other methods and sensitive analysis in Annex 10), it is estimated that under no action (*Option 1*) and if 10% of old smartphones and 2% of old feature phones[57] were to be refurbished, about 22,700 jobs would be required for this process in 2030. This implies a current positive trend given the figure for 2021 was 22,000 jobs. In comparison with this figure, implementing the Energy Label, i.e. Option 4, leads to a small increase in the number of jobs (23,000 jobs). However, Ecodesign options achieve greater numbers: about 25,450 jobs in sub-option 3.1, sub-options 3.2a, 3.2b, sub-option 3.3 and sub-option 5.1, and higher for sub-option 5.2 (25,600 jobs).

For *tablets*, for the "no action" scenario (i.e. *Option 1*) about 7,350 jobs would be required in the **repair/maintenance sector** (i.e., a negative trend compared to the current number of jobs: 9,200). The reduction of the level of employment is smaller with other options (7,600 jobs will be needed under sub-o*ption 3.1, 3.2a* and *5.1*, and 7,700 jobs will be needed under *sub-option 3.3* and *5.2).* The Energy Label option (*Option 4*) would be the less ambitious compared to *Option 1* (7,400 jobs).

As opposed to the repair and maintenance sector, the effect on employment related to the **EU manufacturing sector** is expected to be negative. As many factors determine the level of production (directly and indirectly) and given the difficulty to take them all into account, an estimation has not been possible. Given the small size of the EU manufacturing sector, the effect is expected to be small.

The EU retail sector could be also negatively affected under different options, mainly due to expected sales reduction. A number of factors will determine the evolution of this sector, making it difficult to estimate the size of loss – if any - in employment. For example, in this case, retailers are likely to also sell other equipment and an expected reduction in consumer's cost of ownership also would mean a positive income effect, so they are likely to increase spending on other goods. This could partly compensate for the negative effect on sales (not totally, given the relevant market share of phones and tablets in the electronic devices sector). It is also noteworthy that the fast speed of evolution may imply new kind of devices, with increased and or new functionalities, to appear on the market. This would, again, partly compensate retailers of the abovementioned effects.

6.3.2. Affordability (consumer expenditure)

In general, all proposed options will result in a small increase in purchase prices, which is mainly driven by design and service changes to meet reparability and reliability requirements, thus prices are very similar for those options with specific reparability and reliability requirements. The purchase price methodology is described in Annex 4. Under the same annex, a detailed analysis of the cost calculations per typology of requirement, as researched and estimated during the preparatory study and in this impact assessment, is presented. The product cost impacts per individual measure are based on a technical analysis of changes to be implemented and were subject to stakeholder consultations in the course of the preparatory study. In order to estimate the effects (on prices, but also on durability, repair rates, etc.) of the

[57] And assuming that cordless phones are not refurbished

policy options described under this impact assessment, an iterative process was used. For each of the product subcategories under analysis (low-end smartphones, mid-range smartphones, etc.), a product architecture featuring compliance with a limited subset of requirements[58] was first modelled. Then, further subsets of two-three requirements each were integrated into the modelling in an iterative way, i.e. adding one subset per step, each time re-evaluating the effects (on prices, but also on durability, repair rates, etc.). The order in which measures have been modelled and implemented for this analysis corresponds to the procedure mandated by the Methodology for Ecodesign of Energy-related Products (MEErP), i.e. implementing first measures with the highest cost savings potential for consumers. In case of mobile phones and tablets, these are the measures adressing reparability and next reliability, as these lead to overall longer product lifetime, thus reduced life cycle costs per year of use. The last measures to be implented in this analysis are those with no life cycle cost savings for consumers, but still with reduced environmental impacts and reduced societal life cycle costs. These are the information requirements on upstream greenhouse gas emissions. Where side effects, such as an incentivized unbundling of external power supplies and devices leading to additional replacement purchases of external power supplies, lead to additional costs for the consumer, this is factored in as well. Similarly, repair costs are covered in this analysis as life cycle costs, but where the consumer is undertaking do-it-yourself repairs no labour costs are considered, given that consumers do not consider such work as a cost factor. Given the competitiveness of the mobile phones and tablets market it is assumed, that additional manufacturing and logistics costs lead to corresponding product price increases, but not to excessively increased margins for the manufacturers or retailers. All the details of this process are explained in Annex 4; by means of this analysis, it was possible to derive the below reported figures, which are presented in detail in Annex 10.

The 2030 price of mid-range *smartphones* under the different options is *Option 1* = EUR 500; sub-o*ption 3.1* = EUR 504; sub-o*ption 3.2a* = EUR 505; sub-option 3.2b = EUR 504; sub-o*ption 3.3* = EUR 504; *Option 4* = EUR 500; sub-o*ption 5.1* = EUR 504, sub-o*ption 5.2* = EUR 504.

For *feature phones*, 2030 price under the different options is: *Option 1* = EUR 80; sub-o*ption 3.1* = EUR 80; sub-o*ption* 3.2a = EUR 83; sub-option 3.2b = EUR 83; sub-o*ption* 3.3 =EUR 83; *Option 4* = EUR 80; sub-o*ption 5.1* = EUR 83, sub-o*ption 5.2* = EUR 83. 2030 price for *cordless phones* will come to be EUR 50 for *Options 1, 3.1 and 4,* while it is estimated at EUR 52 for other options.

These cost calculations were subject to stakeholder consultation, without major concerns being raised by manufacturers and other stakeholders regarding their accuracy.

Affordability of access to smartphones might become an issue if this price increase is seen as a relevant barrier by EU consumers. Considering this increase is at most 1%, it is not expected that consumers will be significantly affected. Furthermore, the lifetime of

[58] Please refer to the list of requirements under the section *Option 3: Ecodesign requirements* of this impact assessment. Detailed explanations on the nature/rationale of each requirement are presented under Annex 9.

smartphones is expected to increase from 3.1 (*Option 1*) to 4.14 years (*Option 3.1 and 3.2b*) 4.17 (*sub-option 5.1*), 4.18 (*sub-option 3.2a*) or 4.26 (sub-o*ptions 3.3* and *5.2*). *Option 4* would not imply an extended lifetime.

Tablet purchase prices will increase about 1% on average with the implementation of Ecodesign requirements and is not considered, therefore, and issue of affordability. The purchase price for *Option 1* is EUR 330, for sub-o*ption 3.1* (Ecodesign) the price was estimated at EUR 334 (the same for sub-o*ption 3.2a*, *3.3, 5.1 and 5.2*), and for *Option 4* (Energy label) the purchase price is EUR 331. As with smartphones, the lifetime of tablets is expected to increase from 5 years (*Option 1*) to 5.1 years (*Option 4*), 6 years (sub-o*ption 3.1 and 3.2a*), 5.6 years (sub-o*ption 5.1*) or 6.1 (*sub-option 3.3* and *5.2*).

All policy options lead to a very slightly higher prices. Due to extended lifetimes the costs of ownership (including energy consumption and expenses for repairs) per year of use are lower than under the baseline.

Consumer expenditure

For *smartphones, feature phones and cordless phones*, the *total* consumer expenditure[59] in 2020 in the EU is calculated at EUR 77,208 million, of which EUR 75,025 million smartphones, EUR 1,360 million feature phones and EUR 823 million cordless phones. Following the trend, the aggregated nominal value will be about EUR 80,475 million for 2030. Total annual consumer expenditure declines with all options in the coming years when compared to no-action. It significantly declines for sub-o*ption 3.1* (Ecodesign requirements) (EUR -18,200 million) *sub-option 3.2a and 3.2b* (Extended Ecodesign options) (EUR -18,500 million and EUR -18,300 million, respectively), *sub-option 3.3* (Ecodesign with a repair index) (EUR – 19,000 million), *and sub-option 5.1* (Ecodesign requirements and Energy Label) (EUR –18,300 million). The slight decline for *option 4* (Energy Label) (EUR –2,600 million) is due to a limited effect of lifetime extension across the EU market and the ongoing trend towards higher price devices.

S*ub-option 5.2* shows the highest decline (EUR –19,500 million) in total consumer expenditure. It also presents the lowest annual expenditure for a "typical consumer": annual consumer expenditure for smartphones will decrease from EUR 170 (O*ption 1*) to EUR 166 (*Option 4),* EUR 129 (sub-o*ption 3.1*, *3.2a*, *3.2b and 5.1*), and EUR 127 (*sub-options 3.3* and *5.2*). For *feature phones*, it will reduce from EUR 29.6 (*Option 1*) to EUR 28.6 (sub-o*ption 3.2a*, *3.2b*, *3.3*, *5.1* and *5.2*), and EUR 28.4 (*Option 4*). For sub-o*ption 3.1* there are no changes compared to the baseline. In the case of *cordless phones*, the annual consumer expenditure will decrease from EUR 11.8 (*Option 1*) to EUR 11.6 (Sub-o*ptions 5.1*, *3.2a*, *3.2b 3.3* and *5.2*). There are no changes, compared to the baseline, for other options.

Similar conclusions are found for *tablets*. *Option 4* will imply a minor reduction of *total* annual consumer expenditure compared to "no action" (EUR 700 million less). The remaining options

59 Consumer expenditure includes: acquisition price + energy consumption (electricity) costs + repair costs

would provide the same level of benefits to consumers in terms of expenditure - about EUR 1,000 million per year reduction compared to the baseline scenario: EUR –1,029 million (sub-o*ption 3.1*), EUR -1.036 million (*sub-option 3.2a*), EUR –1,085 million (*sub-option 3.3*) and EUR –1,032 million (sub-o*ption 5.1*). The highest reduction is expected for *sub-option 5.2* (EUR –1,089 million).

The annual expenditure of a tablet's "typical consumer" will decrease from EUR 71.2 (*Option 1*) to EUR 62,2 (sub-o*ptions 3.1, 3.2a, 3.2b, and 5.1*), EUR 69.4 (*Option 4*) and EUR 61.7 (*sub-options 3.3* and *5.2*).

6.3.3. Health, safety and functionality aspects

There are no known negative health impacts from using more efficient appliances as prescribed by the respective options. In fact, this is a way of ensuring that mobile devices comply with specifications and protocols to protect user's and workers' health.

Electronic devices, specifically smartphones and tablets, contain toxic materials that can cause serious health effects in exposed individuals. These materials can also affect human health and pollute agricultural lands and aquifers if not correctly managed after their use.

Under all options considered, toxic materials' use is reduced, particularly for options including Ecodesign requirements. The main beneficiaries will be workers of recycling plants, as a significant number of toxic dioxins and furans that can cause health effects are generated during the recycling process. Halogenated compounds, for example, have been shown to cause reproductive abnormalities, diabetes, thyroid dysregulation and other diseases.

Since the manufacturing process is carried out mainly in non-EU countries but devices will be used by EU consumers, both EU users and non-EU workers will benefit from healthier and safer devices.

Additionally, and especially for Ecodesign options, given that new production must follow the same design criteria, compatibility across devices is assured.

7. HOW DO THE OPTIONS COMPARE?

7.1. Summary of impacts

The impacts of the different policy options at EU level for 2030 and for smartphones, feature phones, cordless phones and tablets are summarised in Table 2. Values included are sales and cost impacts, environmental impacts and social indicators across devices. Absolute values are complemented by percentages indicating the change with respect to the baseline scenario (i.e., *Option 1*). All policy options apply to *smartphones*, a reparability index is not considered for *feature phones* (i.e. *sub-options 3.3* and *5.2*), *cordless phones* are only affected by Ecodesign requirement or none, while for *tablets sub-option 3.2b* does not apply. Similar tables for smartphones plus feature phones plus cordless phones and tablets are available in Annex 10.

Table 2: Smartphones, feature phones, cordless phones and tablets (Aggregated results per policy option, yearly figures for 2030)

Smartphones + feature phones + cordless phones + tablets	Option 1 "No action"	Option 3.1 Eco-design	Option 3.2a Eco-design with feature & cordless (less requirements)	Option 3.2b Eco-design with feature & cordless	Option 3.3 Eco-design with REP index.	Option 4 Energy Label	Option 5.1 Eco-design and Energy label	Option 5.2- Ecodesign, repair index and Energy label	Option 3.1 Eco-design	Option 3.2a Eco-design with feature & cordless (less requirements)	Option 3.2b Eco-design with feature & cordless	Option 3.3 Eco-design with REP index.	Option 4 Energy Label	Option 5.1 Eco-design and Energy label	Option 5.2- Ecodesign, repair index and Energy label
	Absolute values								Comparison with "no action"						
Economic indicators															
Sales (Mn. units)	181	144	141	142	140	177	142	139	-20%	-22%	-22%	-23%	-2%	-22%	-23%
Business revenue (million €)	84145	64778	64390	64642	63691	81737	64631	63146	-23%	-23%	-23%	-24%	-3%	-23%	-25%
Environmental indicators															
Total Energy (PJ)	139	95	96	92	91	126	91	90	-32%	-31%	-34%	-35%	-9%	-34%	-35%
Greenhouse Gas emissions (Mn. t CO2 eq.)	9	5	6	5	5	8	5	5	-37%	-30%	-39%	-40%	-6%	-40%	-41%
Acidification (kt SO2 eq)	85	63	63	62	62	81	62	61	-26%	-26%	-27%	-27%	-5%	-27%	-29%
Total material consumption (t)	116906	80835	81579	77788	< 77788	115307	76571	< 76571	-31%	-30%	-33%	<-33%	-1%	-35%	<-35%
External annual damages (Mn. €)	3419	2441	2573	2403	2377	3266	2379	2341	-29%	-25%	-30%	-30%	-4%	-30%	-32%
Social indicators															
Employment repair and maintenance	30081	33059	33125	33090	33249	30383	33090	33292	10%	10%	10%	11%	1%	10%	11%
Total annual consumer expenditure (Mn. €)	88643	69386	69149	69325	68552	85843	69314	68070	-22%	-22%	-22%	-23%	-3%	-22%	-23%
Repair costs only (Mn. €)	3321	3666	3819	3757	3935	3150	3757	3999	10%	15%	13%	18%	-5%	13%	20%

Economic impacts

With regards to the effects on OEMs we highlight the reduced number of manufactured devices, although this affects mainly non-EU businesses. On the other hand, the increase of repair and maintenance service would be expected to lead to an increase in the numbers of firms (SMEs), and its related level of employment (see social impact below). In general, the manufacturers and retailers could see reductions[60] of the business revenues under some policy options, especially those including a reparability score (i.e. *sub-options 3.3* and *5.2*).

Environmental impacts

For 2030, the most ambitious option (i.e. *sub-option 5.2*), has the highest environmental positive effect (in terms of reduction of GHG emissions and of raw material consumption). Whereas the additional effect of an Energy Label and/or a repair index on top of Ecodesign seems to be not very significant (based on a moderate reaction of the market towards better energy efficiency, i.e. battery endurance), the positive change in the market is however expected to materialise earlier than with Ecodesign requirements only, at least for the Energy Label as it is already well known among consumers. The Energy Label alone has a positive impact as well, but only in the range of 1 to 9% improvement for environmental indicators. Comparing *sub-options 3.2a* and 3.2b, the more ambitious ecodesign option (i.e. *sub-option 3.2b*) presents better results, especially in terms of greenhouse gas emissions. The addition of

[60] As highlighted in the previous sections, this effect should not be seen in 'isolation', i.e. only focussing on the possible effect stemming from the introduction or regulatory requirements. A number of factors will determine the evolution of this sector, making it difficult to estimate the size of losses in revenues. For example, retailers are likely to also sell other equipment and an expected reduction in consumer's cost of ownership also would mean a positive income effect, so they are likely to increase spending on other goods.

a repair index to Ecodesign requirements (i.e. *sub-option 3.3* but especially *sub-option 5.2*) has a bigger improvement on the environmental aspects.

Total material consumption in all the products entering the market will be reduced by 29-30% *(Sub-options 3.1* and *5.1*) in 2030 compared to the baseline. It has not been possible to estimate these values for *sub-options 3.3* nor *5.2*, but in terms of circular economy, positive and greater results are expected (increase of refurbishment rate and longer lifetime). Relevant improvements in terms of external societal damages are achieved, especially for reparability index options, i.e. *sub-option 3.3* and *sub-option 5.2*, about 30% and 32% of reduction, respectively.

Social impacts

Consumers would significantly benefit from the options. The positive effect of all options including Ecodesign requirements (so excluding *Option 4*) is on average 22% lower total annual consumer expenditure, despite the increase in repair costs.

Sub-option 3.3 (Ecodesign plus repair index) and *5.2* (Ecodesign plus repair index plus Energy Label) have the highest social effects. Employment in the repair and maintenance sector is expected to be 11% higher under these scenarios than with no action. This is significantly higher than the impact with *Option 4*, where the employment is expected to increase 1%.

Table 2a provides qualitative information comparing the policy options in terms of the objectives.

Table 2a: Objectives and policy options

Options/impacts relative to the baseline	Avoiding premature obsolescence	Contributing towards a circular economy by facilitating repair and increasing durability	Helping consumers making an informed and sustainable choice at the point of sale	Fostering product designs aimed to achieve cost-efficient material and energy savings
Policy opt. 1	*no change*	*no change*	*no change*	*no change*
Policy opt.3.1	++	+	+-	++
Policy opt. 3.2a	++	+	+-	++
Policy opt. 3.2b	++	+	+-	++
Policy opt.3.3	++	++	++	++
Policy opt. 4	+	+	+++	++
Policy opt. 5.1	++	++	+	++
Policy opt. 5.2	++	+++	+++	+++

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

Table 2b provides, on the basis of the analysis of the impacts, qualitative information comparing the policy options in terms of effectiveness (how each option achieves the specific objectives), efficiency (cost-benefits analysis) and coherence with other pieces of EU law and the overarching objectives of EU policies (a discussion about this comparison is presented in the next section, which then identifies the preferred policy option).

Table 2b: Comparison of policy options

Options	Effectiveness	Efficiency	Coherence
Policy opt. 1	*no change*	*no change*	*no change*
Policy opt.3.1	+/++	++	+
Policy opt. 3.2a	+/++	++	+
Policy opt. 3.2b	+/++	+/++	+
Policy opt.3.3	++	++	+
Policy opt. 4	+/++	+	+-/+
Policy opt. 5.1	++	++	+
Policy opt. 5.2	+++	++/+++	++

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

To determine the level of efficiency of the options, the costs and benefits of each policy option (against the baseline scenario) have been considered. On the cost side, the increase in compliance costs, repair costs, acquisition price, reduction of business revenue and the negative impact on SMEs in the manufacturing and retail sectors have been assessed. As these costs are reflected in annual consumer expenditure, the change in consumer expenditure under the different policy options compared to the baseline has been taken as a proxy of the incremental costs of each option. On the benefit side, not all of the impacts are expressed in economic terms as many are environmental and social gains. In terms of relevance for this study, the incremental benefits of each option are estimated in terms of avoided externalities under the different options compared to the baseline. This includes benefits such as reduction of GHG emissions, acidification and energy consumption.

When evaluating the efficiency of each option,the gains and losses of different groups of affected parties (e.g. suppliers, repairers, etc..) have been considered. In practical terms, to derive the final assessment, no formal weighting has been used. Instead, a judgment has been taken on the relative importance of changes to different groups (suppliers of equipment, repairers, consumers, beneficiaries of environmental improvements).

8. PREFERRED OPTION

Based on the analyses carried out in the previous section, it can be concluded as follows (annex 11 presents in detail a comparison of the options).

Sub-option 5.2 is the most efficient option as it presents the best result both in terms of the social indicators (lower annual consumer expenditure for the equipment, employment gain) and the environmental indicators (reduction in GHG emissions and in raw material consumption). With respect to losses in revenue for manufacturers, it should be noted that these represent a welfare transfer to consumers, resulting in reduced annual consumer expenditure. Yet, as consumers would still experience the same functionality from owning a smartphone or tablet, it can be argued that this also improves efficiency overall (less resource use providing the same utility). Therefore, lost revenues do not represent an economic loss to society. In terms of effectiveness, sub option 5.2 is clearly superior to the other ones. Being based on the synergy between Ecodesign requirements, an energy label and a scoring index on reparability, it would address all the problems identified in the previous sections and propose regulatory measures in line with the specific objectives. Environmental improvements would mainly be achieved through lifetime extending measures, as foreseen by the ecodesign requirements, but also the energy label requirements due to using the energy label as vehicle to communicate a range of environmental parameters in a transparent manner, thus resulting in a likely market pull. Improved energy efficiency of the devices is demonstrated to have also a positive effect on battery lifetimes due to less frequent charging, and thus on overall product lifetime.

The other policy options would have positive impacts (though never higher than sub-option 5.2) for realising some of the specific objectives. The policy options foreseeing ‘tools’ to communicate sustainability aspects to users (options 3.1, 3.2a, 3.2b and 3.3 implying Ecodesign and option 4 on the energy label) would be certainly effective in helping consumers making an informed and sustainable choice at the point of sale. All options are expected to have a positive impact on the objective of facilitating repair and increasing durability and on the objective to achieve cost-efficient material and energy savings. Concerning the objective of avoiding premature obsolescence, the policy options foreseeing – inter alia – Ecodesign measures are those expected to be more effective, thanks to the extension of the lifetime of the devices attained (as a direct effect of the compliance with the Ecodesign requirements).

Concerning the efficiency of the various policy options, options 3.1, 3.2a, 3.2b and 3.3 would be quite efficient. In fact, on one side they would imply, in particular, recurrent costs higher than the baseline due to the necessary product modifications in order to comply with the Ecodesign requirements. On the other side, they would have significant positive impacts(i.e. benefits). The efficiency of options 3.2a and 3.2b also depends on how the markets of cordless and feature phones evolve (expected to be declining). Option 4 (energy label) has the lowest economic impact in terms of reduction of sales and of business revenues, but it also has limited social and environmental benefits, which result ino not very high efficiency. Options 5.1 and 5.2 would have an efficiency similar to option 3.1, 3.2a and 3.2b.

In terms of coherence, all the options foreseeing regulatory approaches (3.1, 3.2a, 3.2b, 3.3, 4, 5.1, and 5.2) would be coherent with the existing waste and product policies. Furthermore, annex 6 shows in detail how these regulatory approaches would be complementary/synergic with the initiatives under development in fields related to product policy, circular economy and consumer rights. Concerning the coherence with the overarching objectives of EU policies, it is interesting to refer to the main objectives of the Green Deal and the CEAP 2020. With this regard, all the options foreseeing regulatory approaches would be coherent with the commitments laid down in the CEAP 2020, in particular those referred to under the Circular Electronics Initiative (*regulatory measures for electronics and ICT (incl. mobile phones,* *tablets and laptops) under the Ecodesign Directive to ensure that devices are designed for energy efficiency and durability, reparability, upgradability, maintenance, reuse and recycling*). Option 5.2, with its 'composite' structure of Ecodesign requirements, scoring index on reparability and Energy Labelling, would seem as the more comprehensive 'reply' to these commitments, thus qualifying as the best also from this viewpoint. Finally, the options foreseeing regulatory approaches (3.1, 3.2a, 3.2b, 3.3, 4, 5.1, and 5.2) would also be coherent the European Climate Law[61], which integrated the goals defined in the Green Deal, in particular on carbon neutrality by 2050. In fact, all options, and in particular sub option 5.2, result in significant reductions of GHG emissions compared to the baseline. Thus, they would directly contribute to the 2030 climate target of at least 55% reduction of net emissions of greenhouse gases.

Based on these considerations, **the sub option 5.2, foreseeing Ecodesign requirements together with a scoring index on reparability plus Energy Label appears as the most suitable one,** as this is the option which, in general, ranks better than the others.

Thanks to its compulsory nature, and the extensive set of requirements Ecodesign would help delivering on the three specific objectives identified in this impact assessment report, i.e. 1) Avoiding premature obsolescence, 2) facilitating repair and increasing durability of these products and key components (e.g. battery and display) and 3) Fostering product designs aimed to achieve cost-efficient material and energy savings. To a small extent, it would also help delivering on the objective 4) Helping consumers making an informed and sustainable choice at the point of sale (there are also Ecodesign information requirements, that have to be made publicly available on free-access websites).

The Energy label, due to its specific design, would help delivering on the three specific objectives 2) facilitating repair and increasing durability of these products and key components (e.g. battery and display) 3) Fostering product designs aimed to achieve cost-efficient material and energy savings and 4) Helping consumers making an informed and sustainable choice at the point of sale. To a small extent, it would also help delivering on the objective 1) Avoiding premature obsolescence (in particular thanks to the prolonged battery lifetime that could be highlighted in the label). The energy savings that can be associated to the energy label **alone** (as per the results of Table 2, option 4) are quantified in 13 PJ, i.e. ~ 3,6 TWh/y. The energy savings that can be associated to the energy label **in combination with Ecodesign,** i.e. as under the preferred option 5.2, can be estimated in the order of 10,4 PJ, i.e. ~ 2,8 TWh/y[62]. This is certainly less than the impact from the Ecodesign option alone (48 PJ, i.e. ~ 13,3 TWh/y), however in absolute terms it still qualifies as significant (this is a similar value to other already

[61] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R1119&from=EN

[62] The energy savings foreseen under option 5.2 (49PJ in total) are due to the synergic action of Ecodesign and Energy Labelling, thus they cannot be derived by simply summing the energy savings from the design options only foreseeing one policy, i.e. option 4 for Energy Labelling (13PJ) and option 3.3 for Ecodesign (48PJ). In order to estimate the shares of impacts under option 5.2 that can be attributed to each of the two policies, a rough repartition can be established by using as weights the energy savings foreseen under the design options only foreseeing one policy, i.e. option 4 for Energy Labelling (13PJ) and option 3.3 for Ecodesign (48PJ). Thus, 21,3% [=13/(48+13)] of the total 49PJ foreseen under option 5.2 would be attributed to the Energy Labelling, i.e. 10,4 PJ.

existing Energy Labelling Regulations, such as Regulation 2015/1094 on professional refrigerators).

The reparability score, incorporated in the energy label, would help delivering on the specific objectives of 2) facilitating repair and increasing durability of these products and key components (e.g. battery and display) and 4) Helping consumers making an informed and sustainable choice at the point of sale. To a lesser extent, it would also help delivering on the objective 1) Avoiding premature obsolescence (the scoring systems is positively affected by the availability of operating system updates over time) and 3) Fostering product designs aimed to achieve cost-efficient material and energy savings (with specific regard to material efficient product designs).

Recent consumer and behavioural studies conducted by the JRC show that there should be a positive effect stemming from quantitative information on material efficiency aspects available for the consumer in the form of a label. In fact, graded labels are the most effective to steer consumer toward more sustainable purchase decisions[63]. Moreover, it has been shown that the communication of reparability information results in an increase in the choice share for the product with the best reparability score relative to the baseline[64]. A more detailed analysis on the consumer acceptance/understanding of a 'multi-dimensional' label (i.e. displaying energy efficiency together with parameters related to material efficiency) is presented in Annex 9.

[63] Dessart, F.J., Marandola, G., Hille, S.L. and Thøgersen, J., Comparing the impact of positive, negative, and graded sustainability labels on purchase decisions, European Commission, 2021, JRC127006
[64] https://op.europa.eu/en/publication-detail/-/publication/46076b42-669a-11eb-aeb5-01aa75ed71a1

9. SENSITIVITY ANALYSIS

A more optimistic trend for EU market is a situation where Eco Rating turns out to yield significant changes in the market without any EU intervention. A new scenario with higher Eco rating penetration (12.5%) is analysed as an alternative (hypothetical) baseline. S*ub-option 5.2* is therefore compared to this alternative baseline for purposes of sensitivity analysis.

Regarding Table 3, we can observe that, even with a more positive development of the baseline, *sub-option 5.2* remains a suitable choice, because its economic, environmental and social impacts are significant and positive in most cases. As we compare it now with a more optimistic baseline, it is reasonable that changes are slightly lower, but the same will happen under the rest of options (see Annex 10). So, *5.2* still represents a considerable net benefit and remains the preferred option.

Table 3: Sensitivity analysis for the preferred option (sub-option 5.2) - yearly figures for 2030

	SENSITIVITY ANALYSIS				
Smartphones + feature phones + cordless phones + tablets	**Original baseline:** 5% EcoRating penetration	**New baseline:** 12.5% EcoRating penetration	**Option 5.2-** Ecodesign, repair index and Energy label	Comparison Option 5.2 with **original baseline**	Comparison Option 5.2 with **new baseline**
	Absolute values			Comparison %	
Economic indicators					
Sales (Mn. units)	181	178	139	-23%	-22%
Business revenue (million €)	84145	82265	63146	-25%	-23%
Environmental indicators					
Total Energy (PJ)	139	135	90	-35%	-33%
Greenhouse Gas emissions (Mn. t CO2 eq.)	9	8	5	-41%	-39%
Acidification (kt SO2 eq)	85	83	61	-29%	-27%
Total material consumption (t)	116906	113152	< 76571	<-35%	< -32%
External annual damages (Mn. €)	3419	3317	2341	-32%	-29%
Social indicators					
Employment repair and maintenance	30081	30352	33292	11%	10%
Total annual consumer expenditure (Mn. €)	88643	87011	68070	-23%	-22%
Repair costs only (Mn. €)	3321	3443	3999	20%	16%

There is also some uncertainty, concerning how better reparability, and in particular a reparability score, would be received by users, as there is no precedent on how the actual market response is for such a novel policy approach. Past market pull experiences, such as the energy labelling of other consumer electronics, show a clear positive effect of these instruments. In any case, the worst scenario could be the one where no positive effects are associated with the reparability score. If the reparability score has no effect, *Option 5.2* would have the same environmental impact as *Option 5.1*. As soon as the reparability score results in actually more repairs being undertaken – for which there are strong preliminary indications – *Option 5.2* is the preferred option.

A second – and more specific - sensitivity analysis on the potential negative effects resulting from overstock of spare parts is presented under Annex 10. For the 6 product segments (entry-level smartphones, mid-range smartphones, high-end smartphones, feature phones, cordless phones and tablets), an hypothetical situation, where the obsolete overstock varies between 10% and 50% of the actual spare parts demand, has been modelled. This analysis leads to the conclusion that the issue of obsolete spare parts stock even, under the worst case scenario of 50% excess stock, only results in very minor additional environmental impacts across all analysed indicators.

10. HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

Policy monitoring and tracking of the progress of the market towards better performing products in terms of ecodesign is facilitated by a mandatory requirement under Energy Labelling Regulation EU 2017/1369 to enter comprehensive performance data in the EPREL database of the European Commission.

An analysis of the products on the market (sales figures derived from generally available market statistics, performance, etc.) can determine if the shift towards more resource efficient products has happened as intended, in particular based on the following indicators, which reflect the general and specific objectives:

Socio-economic information

1. Market penetration (e.g. percentage of sales for improved products or elimination of worst performing products) (Source: Eurostat, Market data, WEEE registers);
2. Overall decline in sales as an indicator of longer product life cycles (Source: Eurostat, Market data);
3. Speed with which market penetration of improved products has occurred, i.e. x number of years for y% penetration (source: Market data);
4. Reduction of the related GHG emissions (To be estimated);
5. Savings (economic) for European consumers (To be estimated);
6. Number of additional jobs created in the EU (source: Eurostat);

Environmental Information

Compliance with the circular economy requirements: The monitoring framework on the Circular Economy as set up by the European Commission consists of ten indicators, some of which are broken down in sub-indicators. However, all these indicators will not be available at a disaggregated level to monitor the impact of ecodesign implementing measures and energy labelling. Only those highlighted in italics are the most relevant ones.

Production and consumption

1. *Self-sufficiency of raw materials for production in the EU (the number of smartphone and tablets, collected and recycled, Extended Producer Responsibility (EPR) organisations can provide this information for the devices collected through their channels);*
2. Restricting the use of hazardous substances *(not in scope);*
3. Green public procurement (as an indicator for financing aspects);
4. *Waste generation (as an indicator for consumption aspects): information available from EPR organisations (WEEE Registers);*

Waste management

5. *Recycling rates (the share of WEEE which is recycled): information available from EPR organisations;*
6. *Dismantling of components (WEEE): information available from EPR organisations;*
7. *Information requirements to facilitate reparability: Source: Database on reparability index (e.g. in France, to be seen if such database can be established at the EU level by putting in place reporting requirements for Member States);*

Secondary raw materials

8. *Contribution of recycled materials to raw materials demand (Source: EPR organisations);*
9. *Trade of recyclable raw materials between the EU Member States and with the rest of the world (Source: Eurostat);*

Competitiveness and innovation

10. *Private investments, jobs and gross value added (Source: Eurostat);*
11. *Patents related to recycling and secondary raw materials as a proxy for innovation.*

An evaluation of the initiative could usefully take place (indicatively) 4 years after entry into force of the measures. The evaluation would build on the information from the above indicators and could usefully be combined with the review process foreseen for ecodesign implementing measures.

Annex 1: Procedural information

1. LEAD DG, DECIDE PLANNING/CWP REFERENCES

Lead DG: DG GROW

Decide number of the underlying initiative: PLAN/2020/9213 (Ecodesign) and PLAN/2020/9217 (Energy Labelling).

2. ORGANISATION AND TIMING

The inception impact assessment was published on 23/12/2020[65], with a feedback period until 27/01/2021.

The following DGs (Directorates General) have been invited to contribute to this impact assessment: SG (Secretariat-General), ENER (Energy), ENV (Environment), CNECT (Communications Networks, Content and Technology), JRC (Joint Research Centre), JUST (Justice and Consumers) and TRADE (Trade). The DG in the lead for this initiative, i.e. DG GROW (Internal Market, Industry, Entrepreneurship and SMEs), met with the other DGs 3 times during 2020-21, to give an update on the ongoing work and share the preliminary versions of the Impact assessment report, together with all the supporting documents.

3. CONSULTATION OF THE RSB

The draft impact assessment report was submitted to the RSB on 18/11/2021. The impact assessment was discussed with the RSB on 15/12/2021. Following the meeting, the RSB issued a negative opinion on 17/12/2021. In order to take the Board's concerns into account, the following modifications have been made to the impact assessment:

RSB recommendations	Revisions introduced
(B) Summary of findings	
(1) The report does not provide enough evidence to back up the proposed options and analysis.	Please see the detailed points discussed below under C.1
(2) The report does not demonstrate that it is proportionate to consider introducing Ecodesign requirements or an Energy label for smartphones and tablets.	Please see the detailed points discussed below under C.2
(3) The scope of the initiative is not sufficiently clear, in particular in relation to other product groups covered by existing Ecodesign regulation.	Please see the detailed points discussed below under C.3
(4) The baseline does not sufficiently incorporate possible sustainability initiatives by market actors and the effects of technological developments on the use of energy and resources.	Please see the detailed points discussed below under C.4

[65] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12797-Designing-mobile-phones-and-tablets-to-be-sustainable-ecodesign_en

(5) The report does not analyse the impacts of the options completely and in enough detail. It does not convincingly demonstrate that the preferred option performs significantly better than other options.	Please see the detailed points discussed below under C.6, C.7 and C.8
(C) What to improve	
(1) The report should read as a standalone document. In particular, it should integrate relevant evidence from the preparatory study in an annex and summarise it in the main report. It should focus on presenting the relevant evidence to justify and structure the intervention and to assess its expected impacts.	Additional evidence from the preparatory study on the topics referred to in the left cell has been integrated in the report, in particular under Annex 4 and Annex 9 (and recalled/summarised in the main text). The information added are related in particular to the: - nature and rationale, - market readiness - expected impacts on durability, reparability and energy efficiency of products, - environmental impacts on each of the proposed Ecodesign requirements, on the energy label and on the reparability score.
(2) The report should provide evidence that the initiative meets the proportionality requirements of the Ecodesign and Energy labelling legislation, which are pre-conditions for action. It should demonstrate that there are significant environmental impacts within the EU and that there are wide disparities in environmental performance between products with equivalent functionality. The report should also demonstrate that there is no overlap between this initiative and the proposed Batteries Regulation	A detailed analysis on the legal basis for the EU action with Ecodesign and Energy Labelling requirements for mobile phones and tablets has been added in the second part of Annex 5, and summarised in the main text (section *Why should the EU act?*); it is shown that the conditions laid down in the Ecodesign Directive and the Energy Labelling Regulation for proposing regulatory measures are met in the specific case analysed in this impact assessment. Concerning the risk of overlap with the Battery Regulation, an analysis on the articulation between the potential Ecodesign and Energy Labelling requirements for mobile phones and tablets, and the provisions of the Battery Regulation (as per the Commission proposal of December 2020[66]) has been added at the end of Annex 6.
(3) The scope of the initiative should be explained and justified. The report should explain the rationale of separating smartphones and tablets from computers and servers covered under Ecodesign Regulation 617/2013. The reasons for separating laptops from closely related products should be explained in greater detail.	A dedicated section on the supporting analysis for the identification of the products (sub)groups to be covered by the policy options has been added at the beginning of Annex 9 (this has been also clarified in the main report, in the policy options description). The reasons for keeping laptops under the review of the Ecodesign Regulation 617/2013, as well as for covering smartphones and (slate) tablets under the same Ecodesign Regulation, are discussed.
(4) The baseline should better include current and likely developments put in place by private actors either at corporate or industry level. For example, it should include selfrepair schemes and eco-ratings and how these would evolve. The baseline should also better incorporate how continued progress in miniaturisation and battery efficiency would affect the use of energy and resources.	As described under section 5.1 (*What is the baseline from which options are assessed*), the baseline has been modified, in order to 'incorporate' and factor in the likely developments put in place by private actors, the Eco rating scheme in particular. The recent self-repair initiative from Apple[32] was not incorporated in the baseline, due to the uncertainties related to the actual EU coverage, timing and typology of support.

66 https://eur-lex.europa.eu/resource.html?uri=cellar:4b5d88a6-3ad8-11eb-b27b-01aa75ed71a1.0001.02/DOC_1&format=PDF

	As added in the section 2.4. ('*How will the problem evolve?*'), it is argued that the expected technological evolution of smartphones and tablets will head towards increasing overall energy consumption and environmental impacts of the industry.
(5) The report should explain how it determined the set of specific measures and defined the reparability index. It should justify why it does not consider alternatives and explain why these were discarded.	Please also see the reply discussed below under C.1 In particular in the part added under Annex 9, it is presented how the optimal set (in techno-economic-environmental terms) of Ecodesign requirements, together with the Energy label and the reparability score, was determined on the basis of the analysis of the preparatory study. An analysis on the potential requirements that had been analysed, but finally discarded, has also been added. A policy sub-option on Ecodesign has been added (and modelled), to show the differences in impacts between imposing only quantitative requirements and quantitative + information requirements on specific aspects (raw materials content, recycled content, etc.).
(6) Impacts should be analysed more comprehensively and presented in more detail. The report should analyse consumer behaviour under different ownership models for mobile phones. It should also discuss the expected reactions from third-country manufacturers in more depth, taking into account global market dynamics, including strategic innovation, obsolescence and 'versioning' strategies. It should assess the risk of regulatory retaliation and other unintended consequences. The environmental impacts of the proposed options should be analysed in greater detail; e.g. the material efficiency of mandating spare part inventories to be held available for a specific duration (and potentially unused). More generally, the report should be clearer whether the reported costs and benefits systematically relate only to those directly affecting the EU or globally.	An analysis on the different ownership models for mobile phones, and their effect on the user behaviour, has been added under Annex 5 (at the end of the subsection '*the consumer perspective'*), and referred to in the main text, in the section 2.1 on 'problem definition'). An analysis on the expected reactions from third-country manufacturers has been added in the main text, in the subsection *Indirect economic impacts for businesses*. A sensitivity analysis on the potential negative effects resulting from overstock of spare parts has been added under annex 10, and summarised in the main text. Overall, this sensitivity analysis leads to the conclusion that the issue of obsolete spare parts stock even, under the worst case scenario of 50% excess stock, only results in very minor additional environmental impacts across all analysed indicators. Whether the reported costs and benefits systematically relate only to those directly affecting the EU or globally, has been clarified throughout the report
(7) The report does not convincingly explain why the costs of smartphones and tablets would only marginally increase. Several of the proposed measures, such as increased inventory requirements and including protective cases, would seem expensive.	A detailed analysis of the cost calculations per typology of requirement, as researched and estimated during the preparatory study and in this impact assessment, has been added under Annex 4, and recalled in the main text.

(8) The report should better justify why it considers that the preferred option performs best. It should link the scoring of options more closely to the differences in analysed impacts. In particular, it is not clear why the preferred option should contain an Energy label, as it reduces environmental impacts only marginally. The consumer's understanding and acceptance of a multi-dimensional Energy label, which combines energy and material efficiency indicators, should be clarified.	The scoring of the options has been revised, as well as some further analysis and comments have been included in the section related to the choice of the preferred option. An analysis of the relevance of the energy savings deriving from the proposed energy label has been added in the second part of Annex 5 (in particular, related to the first Energy Labelling criterion, 'a significant potential for saving energy or other resources'), and referenced in the main text. Furthermore, legal analysis in support of the feasibility to introduce material efficiency information/icons has been added to Annex 5. An analysis on the consumer acceptance/understanding of a 'multi-dimensional' label has been added under Annex 9, and referenced in the main text, under sections 5.4 (description of the policy option on energy label) and 8 (preferred option).

The impact assessment report was then resubmitted to the RSB on 08/04/2022. The RSB issued a positive opinion on 03/05/2022. In order to take the Board's concerns into account, the following modifications have been made to the impact assessment:

RSB recommendations	Revisions introduced
(B) Summary of findings	
(1) The comparison of options is not sufficiently clear and the justification for the choice of the preferred option continues to be insufficient.	Please see the detailed points discussed below under C.1, C.2, C.3 and C.4
(C) What to improve	
(1) While the revised report provides a more fine-tuned scoring of options, it is still not a sufficient basis for comparing them. The weighing of the individual criteria should be set out clearly. For instance, while the assessment of economic impacts distinguishes impacts on EU businesses and citizens and impacts on businesses outside the EU, it is not clear how this is considered in the overall assessment of efficiency of the options. Because of this, the justification for the choice of the preferred option is also insufficient and should be strengthened.	An explanation on how the effectiveness and efficiency of options have been evaluatued, taking into account all the interested parties (suppliers, repairers, etc..) has been added in section 7, '*How do the options compare?*'. Additional arguments are provided in section 8 (preferred option).
(2) Despite the additional analysis presented on the impacts of specific measures included under various options, the assessment of impacts on consumer prices should be further strengthened. The report should justify the assumption that the increase in prices consumers would pay would equal, but not exceed, the increase in manufacturing costs, by providing, for instance, the information on the degree of competition in the smartphone/tablet market.	Further explanations have been added to the main text, in particular on the approach/rationale behind the analysis presented in Annex 4. This is reflected in section 6.1.1 and section 6.3.2.

(3) While the report provides a more comprehensive and detailed analysis of impacts, it should be clearer about the conclusions from the analysis. It should explain how the largely negative economic impacts on non-EU manufacturers are set against the impacts on EU businesses that are largely positive for the SME repair sector when it comes to the overall assessment of economic impacts. The report should avoid conclusion ambiguities, for example, describing economic impacts as 'the lowest' without specifying whether such impacts are positive or negative and for whom. It should also further develop the analysis of the impact of different ownership models on consumers' choices and on different interoperability policies concerning the software embedded in devices.	The nature of the economic impacts, in particular their repartition between EU and non-EU businesses as a circular economy initiative has been clarified in the main report (section 6.1.9) and additional arguments are provided in section 8 that lost revenues do not represent a cost to society. Clarifications on the nature of impacts have been added in section 6. It has also been clarified, in the main report, that software interoperability is part of the adressed problem of a fragmented OS version landscape (section 2.1) and that the OS update requirements could possibly have positive impacts on mainly SMEs, in particular application developers (section 6.1.5).
(4) The report should include in the section on the preferred option a statement on the degree of consistency of the initiative with the European Climate Law, based on the analysis of environmental impacts.	As required, an analysis of the degree of consistency with the European Climate Law has been integrated in the main text (section 8).

4. EVIDENCE, SOURCES AND QUALITY

Two recent reports from the Joint Research Centre[67,68] assessed the relevance of material efficiency aspects for smartphones and tablets, with the aim of compiling a list of possible measures to improve their performance in terms of durability, reparability, upgradability, use of materials and recyclability.

A preparatory study[69] concluded in March 2021 identified a number of areas for potential regulatory intervention, related to design for reliability, ability of the product to be disassembled and repaired, availability of operating system version upgrades, data deletion and transfer functionalities, provision of appropriate information for users, repairers and recyclers and battery endurance.

[67] Cordella, M., Alfieri, F., Sanfelix Forner, J., 2020. Guide for the Assessment of Material Efficiency: Application to Smartphones. Publications Office of the European Union, Luxembourg, 2020. ISBN: 978-92-76-15411-2, doi: 10.2760/037522

[68] Tecchio P., Ardente F., Marwede M., Clemm C., Dimitrova G. Mathieux F., 2018. Analysis of material efficiency aspects of personal computers product group. Luxembourg: Publications Office of the European Union. ISBN 978-92-79-64943-1 doi:10.2788/89220

[69] https://op.europa.eu/it/publication-detail/-/publication/a7784be4-853d-11eb-af5d-01aa75ed71a1/language-env

This impact assessment also benefitted from the technical support of external consultancy company, BIO Innovation Service[70] (Lead for the Specific Assignment).

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[70] https://www.biois.eu/

Annex 2: Stakeholder consultation

In the context of the initiatives 'Designing mobile phones and tablets to be sustainable – ecodesign'[65] and ‘Energy labelling of mobile phones and tablets – informing consumers about environmental impact’[71], a wide range of consultations took place, with the aim to ensure that the interests of all relevant sectors, as well as citizens, non-governmental organisation, standardisation organisation, etc., were duly taken into account. The feedback obtained from stakeholders via the different tools mentioned below contributes to the analysis together with evidence from different sources including desk-research.

Stakeholder mapping

A wide range of stakeholders is concerned by this initiative:

- MS (Member States): MS representatives and National Governments
- Industry: large Original Equipment Manufacturers, which play an important role in the market
- SMEs (small and medium enterprises): In terms of market share they are certainly not the main player in the mobile phones and tablets sector, however there are European SMEs – in the order of some thousands - working on services or activities related to these products (product assembly, repair and maintenance).
- Environmental and consumer NGOs (non-governmental organisations) are a typical stakeholder in the framework of the consultation process for Ecodesign, with the aim to promote citizen rights, environment and sustainable development.
- Standardisation organisations: to be able to impose requirements on the energy efficiency and the material efficiency of mobile phones and tablets, the availability of standard measurement methods will be crucial. Such methods would be developed in conjunction with standardisation organisations, where relevant. This shows the importance of this stakeholder category, in particular at the level of European standardisation organisations, CEN, CENELEC and ETSI.
- 'Users": mobile phones and tablets are iconic products, massively present in everyone’s life nowadays. Therefore almost every citizen could be interested/affected by the present initiatives.

Consultation method and tools

In the context of the activities linked to the initiatives referred to in the beginning of this Annex, an inclusive and articulated stakeholder consultation process took place, with the aim to gather feedback from a very wide audience.

- As part of the preparatory study[69], two stakeholder meetings were organised. The main participants were from relevant industrial sectors and environmental organisations. The

[71] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12798-Energy-labelling-of-mobile-phones-and-tablets-informing-consumers-about-environmental-impact_en

meetings were devoted to present and discuss the findings of the preparatory study, i.e. the techno-economic-environmental analysis in support of the preparation of the regulatory measures.

- During the preparation of the impact assessment, a meeting of the Ecodesign Consultation Forum (as required by Article 18 of the Ecodesign Directive) was convened on 28 June 2021. This Forum is composed of 30 Member States and 30 stakeholder organisations (business, environmental NGOs, consumer organisations, standardisation bodies and additional expert observers when required). The meeting was aimed to the presentation and discussion about the potential Ecodesign and Energy Labelling requirements for mobile phones and tablets
- A public consultation[72] was launched on 31 May 2021, with feedback period until 23 August 2021, to collect feedback from all stakeholders on potential new measures and to collect information about users' habits, preferences and choices related to their purchase, usage, repair and disposal of mobile phones and tablets.
- individual (ad hoc) consultations were also held with selected stakeholders (e.g. on specific technical aspects) on a continuous basis

The chart below shows the level of involvement of the identified stakeholder categories in the various consultations/meetings in the framework of this initiative.

√: the party has significantly contributed to the specific consultation √: the party has contributed in a limited way to the specific consultation	**Member States**	**Industry (OEMs)**	**SMEs (Repairers, etc.)**	**Environmental and consumer NGOs**	**Standardisation organisations**	**Users**
Meetings – prep. study	√	√	√	√	√	
Meeting – after prep. study	√	√	√	√	√	
Open public consultation			√			√
Consultation Forum	√	√	√	√	√	

Stakeholder consultations within the preparatory study

The preparatory study on mobile phones, cordless phones and tablets started in April 2020 and was completed in March 2021. The first draft task report on the scope (Task 1) and market analysis (Task 2) were published on 12th June 2020, followed by the first stakeholder meeting on 13th July 2020. Stakeholders could provide feedback on draft Task 1 and 2 reports until 10th August 2020. Draft Task 3, 4, 5 and 6 reports were published in October and November 2020.

[72] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12797-Designing-mobile-phones-and-tablets-to-be-sustainable-ecodesign/public-consultation_en

Draft Task 7 report was published on 16th December 2020. The second stakeholder meeting took place on 18th December and stakeholders could provide their written comments for Tasks 3-6 until January 8th, 2021 and for Task 7 until January 17th. The final preparatory study report was published on 3rd March 2021.

Besides the official stakeholder consultations, the project team of the Preparatory Study was in regular exchange with all relevant stakeholders such as manufacturers, repairers, NGOs, policy makers, etc. All information (incl. registration, documents, updates, etc.) was communicated through the dedicated project website https://www.ecosmartphones.info/.

Stakeholder consultations after the preparatory study

Within the follow-up process related to the Impact Assessment, a stakeholder meeting was organised on 16th April 2021, discussing in detail the main changes/updates in particular for the final version of Task 7 of the preparatory study. This updated Task 7 report took into account main stakeholder inputs and improvement suggestions.

Consultation Forum meeting on mobile phones and tablets - Minutes

The minutes are available at: https://ec.europa.eu/docsroom/documents/46696

Public consultation

A public consultation[73] was launched on 31 May 2021, with feedback period until 23 August 2021, to collect feedback from all stakeholders on potential new measures and to collect information about users' habits, preferences and choices related to their purchase, usage, repair and disposal of mobile phones and tablets. After the closing of the public consultation, 611 replies were submitted through EU Survey. Concerning the various typologies of respondents (research institutions, administrations, individuals, company, business organisations, etc.), there was a clear predominance of EU citizens that replied as individuals (90% of the respondents). In terms of country of origin of the respondents, there was a net majority of Germans (more than 50% of respondents), with the other countries homogeneously represented. A dedicated report, 'Brief factual summary of the replies received to the public consultation on the initiatives: - Designing mobile phones and tablets to be sustainable – ecodesign and - Energy labelling of mobile phones and tablets – informing consumers about environmental impact', describes in detail the factual results. The report is available at https://circabc.europa.eu/ui/group/418195ae-4919-45fa-a959-3b695c9aab28/library/f33a0226-e7b8-4753-b235-cefc2ebeaca5

Overall messages from the consultation process

[73] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12797-Designing-mobile-phones-and-tablets-to-be-sustainable-ecodesign/public-consultation_en

All categories of stakeholders identified in the stakeholder mapping participated in various consultation activities, therefore the outcomes of the consultation process were of great help in the analysis and the formulation of the policy proposals.

The meetings in the framework of the preparatory study and of the technical assistance study provided an early opportunity to promote stakeholder engagement, and to collect technical data. The public consultation gave useful input for the modelling assumptions on the user behaviour[74], and the formulation of potential energy efficiency or material efficiency requirements under an Ecodesign regulation and the energy labelling scheme. The Consultation Forum meeting helped the Commission in understanding in detail stakeholder views on the various aspects of potential Ecodesign requirements on mobile phones and tablets; there was a general consensus in proceeding with the analysis and formulation of these requirements, with many detailed technical comments.

The stakeholders' opinions, with regard to potential regulatory measures on the environmental impact of mobile phones and tablets, can be summarised as follows:

- the EU Member States cautiously welcomed the Commission work on potential ecodesign requirements and energy labelling of mobile phones and tablets (concerning the latter, advocating in particular for the inclusion of a reparability score in the energy label); some concerns on the testing burden (in particular related to the number of devices to be tested) were raised.

- the standardisation organisations highlighted some caveats concerning the direct 'use' (in terms of classifications, definitions), for regulatory purposes, of the EN 45554 standard, developed in reply to the Commission's standardization request M/543[75].

- industry (original equipment manufacturers) main players were proactive and participative during the process. While they supported, in general terms, the preparatory work on the potential Ecodesign requirements for mobile phones and tablets, they expressed some reservations, in particular on the draft requirements on improved reparability and spare parts availability. They were not supportive of the proposed energy labelling scheme, claiming that the benefits are not fully clear, given that manufacturers are already highly incentivized to ensure efficient phones for end-user satisfaction.

- SMEs, mainly working in the field of repair, refurbishment and recycling, judged as important (a game changer, in some cases) the proposed material efficiency requirements on durability, reparability, upgradability, maintenance, reuse and recycling.

[74] Such as the average daily repartition of tasks (phone calls, chat, streaming media, gaming, etc..) by users of smartphones and tablets. This information helped in setting the methodology for the testing and calculation of the energy efficiency index for the devices.

[75] C(2015) 9096 final

- environmental and consumer NGOs, as well as repairers' organisation, welcomed the Commission work on potential ecodesign requirements and energy labelling of mobile phones and tablets.

Annex 3: Who is affected and how?

1. Practical implications of the initiative

The initiative will concern a significant share of EU population and repairers, and given the small EU manufacturing base only few EU manufacturers of mobile phones, cordless phones and tablets.

Consumers: the impacts associated to the preferred option will consist in an extension of the lifetime of the devices as well as more transparency and clarity about their environmental impacts. Improved energy efficiency of the devices is demonstrated to have also a positive effect on battery lifetimes due to less frequent charging, and thus on overall product lifetime. The proposed Ecodesign requirements on reparability, ease of disassembly and on preparation for reuse are expected to significantly ease the repair process/choice. Longer and continued support of the operating system with updates and upgrades will remove one of the main barriers for extended use of smartphones and tablets

Manufacturers of mobile phones, cordless phones and tablets: the dominating effect of lifetime extending measures (foreseen under the preferred option), regarding the various domains repair, reuse and reliability, is an anticipated decline in new sales and related environmental impacts stemming from production. There would be also an administrative burden for business, related to the price of testing increased by the new requirements. The expected increase in the quality of the devices (as an effect of the requirements foreseen under the preferred option) would nevertheless increase the competitiveness on the global market. The landscape of mobile phone producers is characterised by large companies serving the global market, such as Apple, Samsung, Huawei, and Xiaomi. Few mid-size companies are active in the market, such as Gigaset in Germany, producing smartphones for a few years now and being also the largest European manufacturer of cordless phones. The product portfolio of Philips also includes cordless phones. In general there is very little overlap of manufacturers of smartphones and cordless DECT phones. French based companies Wiko designs and develops smartphones, which are available in some European countries. Archos, another French company, and BQ from Spain supply smartphones and tablets. Some small companies, such as Fairphone and Shift, put particular emphasize on sustainability aspects, although their market share is quite small and production is also outside EU. Several former European brands, such as Nokia and Alcatel, are now owned by high-tech companies from outside Europe. There is a relevant overlap of manufacturers in the mobile phone and tablet business, but besides the large smartphone manufacturers there are also those tablet brands, which are rather rooted in the computer business, such as Dell and Lenovo. There are some smaller EU brands in the tablet market, but with a very minor overall market share. Final production of mobile phones, cordless phones and tablets – among global and EU brands alike – is almost exclusively located in East Asia and particularly in China. The main components such as radio interfaces (baseband chip), processors, flash memory, computer network interfaces, displays, batteries, cameras and audio components come from various regions including Asia, North America and to a small extent Europe. Printed Circuit Boards for these products are typically manufactured in Asia, but Austrian based AT&S is a relevant player in this PCB segment. The value chain is considerably large.

Retail sector: the dominating effect of lifetime extending measures (foreseen under the preferred option) could also reverberate on this sector, mainly due to the expected sales reduction. However, a number of factors will determine the evolution of this sector, making it difficult to estimate the size of loss – if any - in employment. For example, in this case, retailers are likely to also sell other equipment and an expected reduction in consumer’s cost of ownership would also mean a positive income effect, so they are likely to increase spending on other goods. This could partly compensate the negative effect on sales. It is also noteworthy to highlight that the fast speed of evolution may imply new kind of devices, with increased and or new functionalities, to appear on the market. This would, again, partly compensate retailers of the abovementioned effects.

Public authorities: The impact would be associated with surveillance and enforcement of two additional regulations (one Ecodesign and one Energy Labelling Regulation).

SMEs: SMEs belonging to the repair and maintenance sector are expected to strongly benefit from the initiatives, in particular thanks to the proposed Ecodesign requirements on reparability and ease of disassembly. Not only will new repairers appear in the sector, but also existing ones will grow (as described in detail in Annex 10, see also Annex 12: The SME Test).

To a minor extent, workers of recycling plants would benefit from the proposed Ecodesign information requirements on the manufacturing phase of certain components (as described in Annex 9), as the use of toxic materials use would be reduced.

Other specific sectors or regions: few mobile phone manufacturers are based in the EU and they have only a very small market share. In light of the fact that the vast majority of economic operators that would be potentially affected are not based in the EU, this initiative would not affect specific sectors – others than those listed above - or regions in the EU.

2. SUMMARY OF COSTS AND BENEFITS

I. Overview of Benefits (total for all provisions) – Preferred Option (5.2)		
Description	***Amount (yearly figures for 2030, all devices)***	***Comments***
Direct benefits		
New SMEs in repair/maintenance sector (nº firms)	(+++) Not only new repairers will appear in the sector but also existing ones will grow	Business
Promoting investment in the production of more energy efficient devices	Imposes requirements in terms of Ecodesign, energy efficiency and reparability, which implies investment (+++)	Business

Reduced GHG emissions (mt CO_2 eq.)	-4	Society
Reduced energy consumption (PJ)	-49	Consumer
Reduced acidification (kt SO_2 eq.)	-24	Society
Employment creation in repair/maintenance sector (nº jobs)	+3,200	Society
Reduced total annual consumer expenditure (million €)	-20,600	Consumer
Reduced societal external annual damages (million €)	-1,000	Society
Contribute to circular economy	Material reduction is expected (decrease of more than 40,300 tons of materials). In addition, it can promote the reuse of goods by providing more certainty regarding the remaining lifespan after first use.	Society
Indirect benefits		
Reduced other environmental impact related to the production, transport and disposal of products	Positive effect due to a significant reduction on sales (+++)	Society
Ensure user's health, compatibility across other devices and workers safety during production process	Reduces user and worker exposition to dangerous and toxic materials. Devices must follow the same production criteria that assures compatibility (+++)	Society
Positive impact on the deployment and diffusion of innovations	Encourages innovations to achieve new requirements that will be promoted through the supply chain. Promotion of repair skills among users (+++)	Business

(1) Estimates are relative to the baseline for the preferred option as a whole (i.e. the impact of individual actions/obligations of the preferred option are aggregated together); (2) Please indicate which stakeholder group is the main recipient of the benefit in the comment section;(3) For reductions in regulatory costs, please describe details as to how the saving arises (e.g. reductions in compliance costs, administrative costs, regulatory charges, enforcement costs, etc.; see section 6 of the attached guidance).

II. Overview of costs – Preferred option (5.2), all devices							
		Citizens/Consumers		**Businesses**		**Administrations**	
		One-off	**Recurrent**	**One-off**	**Recurrent**	**One-off**	**Recurrent**
Higher compliance costs	Direct costs			(+++) Higher costs. Production and supply chain changes, equipment testing, and capital expenditure for adaption (manufacturing processes, logistics)	(+++) Higher costs. New personnel with Ecodesign competencies, to carry testing and verification, after-sales, maintenance activities, etc.	(+++) Higher costs. Setting up the enforcement process, government expenditure for conformity review, establishing minimum requirements	(+++) Higher costs. Monitoring compliance with the requirements
	Indirect costs			(+) Higher up-front cost of products due inter alia to more accurate assembly, better qualified manufacturing work force, etc.	(+) Increased cost of products due to higher costs of minimum requirement obligations		
Reduced business revenue for manufacturers (Mn €)	Direct costs				Business revenue will reduce annually up to –21,000 in 2030		
Reduced nº SMEs in manufacturing sector	Direct costs				(-) Negatively because of lower sales, although other factors		

					must be considered		
Reduced nº SMEs in retail sector	Direct cost				(-) Negatively affected because of lower sales, although other factors must be considered		
Reduced employment in manufacturing sector	Direct costs		(-) Negatively affected because of lower sales, although other factors must be considered				
Higher repair costs (Mn €)	Direct costs		Repair costs will increase annually up to + 700 in 2030				

(1) Estimates to be provided with respect to the baseline; (2) costs are provided for each identifiable action/obligation of the preferred option otherwise for all retained options when no preferred option is specified; (3) If relevant and available, please present information on costs according to the standard typology of costs (compliance costs, regulatory charges, hassle costs, administrative costs, enforcement costs, indirect costs; see section 6 of the attached guidance).

NB: The figures presented on these tables (I and II) are 2030 projections.

Previous tables provide a general vision about sub-option 5.2 implications, both positives and negatives. While negative effects mainly concern businesses and administration, considerable benefits to consumers and society are expected, greater than those achieved under the other initiatives. This results in a positive final balance, making this option the most suitable to implement.