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COMMISSION STAFF WORKING DOCUMENT

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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Annex 10: Impacts of the policy options

ECONOMIC IMPACTS

I. Compliance costs

Compliance costs refer to costs incurred by the relevant parties (businesses, citizens, etc.) to comply with any new requirement. These will include costs to re-design, change production lines, planning and managing stock of spare parts over extended times, etc.

II. Administrative burden

Administrative burden for economic operators

Administrative costs are the costs incurred by enterprises, the voluntary sector, public authorities and citizens in **meeting new legal obligations** to provide information on their action or production, either to public authorities or to private parties (European Commission, 2017).

One of the administrative burden for *business, as was mentioned on Section 6*, is related to the increase of **testing costs due to** these new design requirements and energy and reparability features (hire personnel, training on testing, adapting processes, establishing a new registration database, etc.). Tests can be run at different product development stages. Unit test is the first one, usually conducted on parts of the mobile devices by the developers at an early development stage. Factory tests are run during the manufacturing and assembly stage. Finally, certification tests are performed before the device is put on the market. Other barrier we can state regarding Ecodesign, Reparability scoring and Energy Label policy options are those from providing labels and presenting them at the point of sales and/or at online platforms.

Administrative burden for citizens

There is no administrative burden/cost for *citizens.*

Administrative burden for authorities

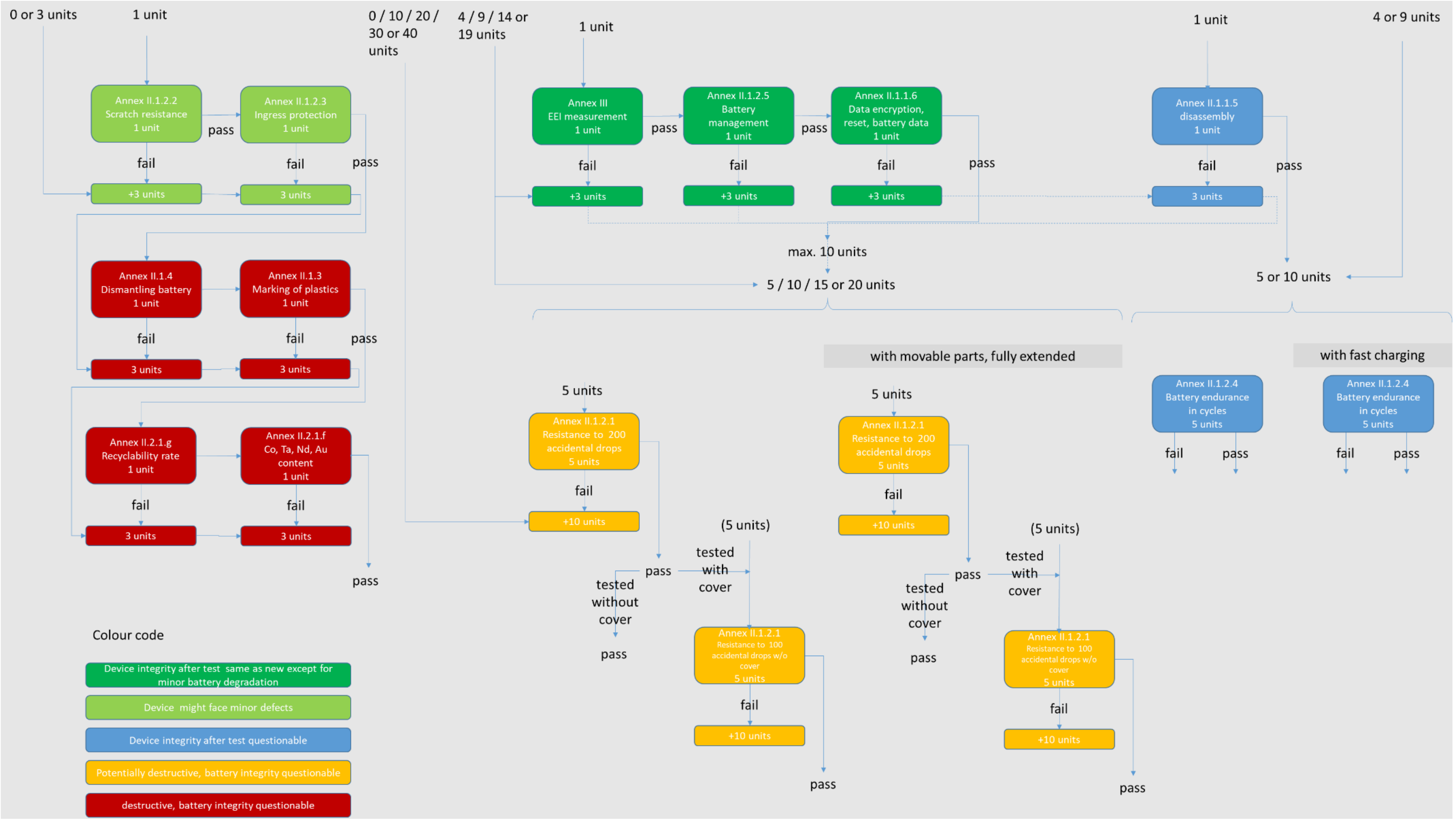
There is a limited burden for *surveillance authorities*, in case of a level 1 market surveillance activity covering only a check of the CE mark as such and the Declaration of Conformity. A level 2 check covering datasheets, the technical documentation and test documentation to be provided by the supplier requires more human resources, but major costs will be experienced when physical checks and tests of the product are undertaken (level 3), which comprises battery endurance measurements, reliability tests, re-engineering activities to verify the recyclability rate, disassembly depth, accuracy of repair information and similar.

A strategy to test product compliance against all Ecodesign requirements is depicted in Figure 34. The overall goal of this test sequence is to minimize the number of units to be tested. As some tests affect the integrity of the device and/or are destructive and/or have an impact on battery performance not all tests can be undertaken with the same device, least the battery tests and repeated free fall tests, which for statistical reasons have to be undertaken with batches of 5 units. Minimum number of test units is 11, if all tests are passed, if the manufacturer declared to have achieved compliance against the criterion of 200 repeated free falls without a protective cover, if the device is not a foldable or otherwise expandable phone, and if the device does not provide fast charging. A more realistic case is 21 units, where all tests are passed, but the manufacturer declared to have tested the device with a cover against the criterion of 200 repeated free falls and where the devices provide the option of fast charging. In case the device fails in individual tests and another test run is required as stipulated in the regulation, the number of required test units can increase significantly. The theoretical worst case for a compliant product, for which compliance is only verified by the market surveillance authority after a second test run with additional units is 74 test units, even with following the optimized test strategy depicted below, making reuse of test units for other tests wherever possible.

Product samples have to be provided for free by the supplier, but market surveillance authorities also purchase units under a cover identity, and then costs can only be reclaimed in case of non-compliance. This is actually a general rule, according to Regulation (EU) 2019/1020, Art. 15: "Member States may authorise their market surveillance authorities to reclaim from the relevant economic operator the totality of the costs of their activities with respect to instances of non-compliance." Vice versa, the authorities have to bear test costs in case of product compliance. Typical test costs for other energy-related products against current Ecodesign criteria are roughly in the range of 2.000 – 7.000 €. Test costs for smartphones and tablets in particular are likely to cost significantly more than this due to the comprehensive test requirements and also the duration of some tests (battery endurance in cycles requires test durations of several months). Total test costs in the range of 20.000 – 30.000 € is more likely, plus product costs in case of purchases under cover identity, which is another 10.000 € in case of 21 units to be acquired and a typical purchase price of 500- €. As can be seen from the required number of test units, main cost driver for market surveillance authorities is the repeated free fall test and the battery lifetime tests. Test time for repeated free fall tests is rather short, maximum 3 hours per unit, but labour intensive, mainly to check the device for defects and malfunction after a given number of falls. The battery endurance in cycles test runs for several months, but the charging-discharging cycle and data logging is automated and requires little intervention.

These overall rather high costs for level 3 compliance checks are a general trend for reliability requirements, which require a sound statistical basis, i.e. a deviation from the typical approach to test first only one unit to verify compliance with any Ecodesign requirements. Such an approach is feasible for parameters, which are not subject to probability principles as is the case for reliability.

Figure 34: Smartphones – Test sequence strategy for market surveillance



III. Business *revenue*

Smartphones, feature phones and cordless phones

Figure 35 shows the business revenue for *smartphones*, *features phones and cordless phones* under the different policy options. To estimate revenues, the purchase prices of low-range, mid-range and high-range smartphones for different policy options estimated in European Commission (2021) have been considered and adapted to the requirements under the policy options: Purchase price calculations are based on the analysis of technical design options required to respond to the requirements. In comparison to Annex 4, the figures of Table 10 are rounded up. Resulting purchase prices are listed in Table 36.

Table 36: Purchase prices for smartphones, feature phones, cordless phones and tablets per policy option

	Low-end smartphone	Mid-range smartphone	High-end smartphone	Feature phone	Cordless phone	Slate tablet
Current product price (€) = option 1	200	500	1.000	80	50	330
Option 3.1	205	504	1.005	80	50	334
Rationale: Purchase price changes roughly correspond to those resulting from the implementation of the full range of technical design measures as listed in Annex 4, except for feature phones and cordless phones, which are not covered by this option.						
Option 3.2a	206	505	1.006	83	52	334
Rationale: Purchase price changes roughly correspond to those resulting from the implementation of the full range of technical design measures as listed in Annex 4, but as some of the information related requirements, which are expected to have a slight cost reduction effect (mainly related to logistics), are not included in this option, prices are expected to be slightly higher than in the other options.						
Option 3.2b	205	504	1.005	83	52	334
Rationale: Purchase price changes roughly correspond to those resulting from the implementation of the full range of technical design measures as listed in Annex 4.						
Option 3.3	205	504	1.005	83	52	334
Rationale: Purchase price changes roughly correspond to those resulting from the implementation of the full range of technical design measures as listed in Annex 4. For smartphones and tablets the reparability score incentivizes technical solutions, which lead on average to marginal further product price increases (< 0,50 €).						
Option 4	200	500	1.001	80	50	331
Rationale: For smartphones and tablets the energy label incentivizes technical solutions (but does not set specific minimum requirements making design changes mandatory), which lead on average to marginal further product price increases (20% of the maximum price increase as per full implementation of technical options). Feature phones and cordless phones are not covered by this option.						
Option 5.1	205	504	1.005	83	52	334
Rationale: Purchase price changes roughly correspond to those resulting from the implementation of the full range of technical design measures as listed in Annex 4. Energy label will provide further transparancy in the market, but is not expected to result in further cost relevant design measures, according to the cost analysis in Annex 4. Feature phones and cordless phones are not covered by the Energy Label, product purchase prices correspond to option 3.2b.						
Option 5.2	205	504	1.005	83	52	334

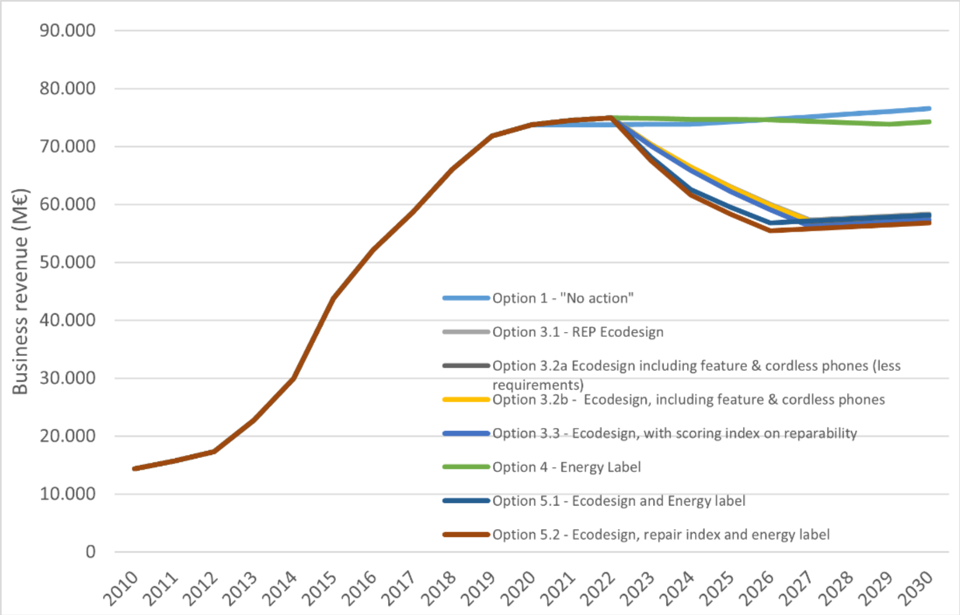
Rationale: Purchase price changes roughly correspond to those resulting from the implementation of the full range of technical design measures as listed in Annex 4. Energy label and reparability score will provide further transparancy in the market, but is not expected to result in further cost relevant design measures, according to the cost analysis in Annex 4. Feature phones and cordless phones are not covered by the Energy Label and reparability score, product purchase prices correspond to option 3.2b.

As representative smartphone and, in order to observe how prices have been affected by different options, the 2030 purchase prices of a mid-range smartphone are follows (see Table 36): *Option 1* = EUR 500; *Sub-option 3.1* = EUR 504; *Sub-option 3.2a* = 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, *Option 5.2* = EUR 504.

For *feature phones*, new prices for 2030 are as follows: *Option 1* = EUR 80; Sub-o*ption 3.1* = EUR 80; *Sub-option 3.2a* = 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, *Option 5.2* = EUR 83.

2030 prices for *cordless phones* will come to be EUR 50 for *Option 1*. This price is maintained under *sub-option 3.1* and *Option 4*, while it rises to EUR 52 under *sub-options 3.2a*, *3.2b*, *3.3*, *5.1* and *5.2*. Options including Ecodesign requirements (i.e., sub-o*ption 3.1*, *3.2a and 3.2b*), Ecodesign requirements with an energy label (i.e., sub-o*ption 5.1*) and Ecodesign requirements with a repair index (i.e. sub-o*ptions 3.3 and 5.2*), would imply a significant reduction on business revenue if the estimated price increase took place (due to expected lower sales of new devices given the extended lifetime and a high acquisition price under these options, that influence consumer behaviour). The option of establishing an Energy Label (*Option 4*) could also imply a reduction on revenues but much lower. The main reason is that with Energy Label, as lifetime does not improve as much as with Ecodesign, the number of devices sold will not change in the same amount. For example, while under Ecodesign (sub-o*ption 3.1*) sales are reduced by 33 million units in comparison with no-action scenario, an Energy Label (*Option 4*) will only reduce this value in 4 million units.

Figure 35: Smartphones, feature and cordless phones – Yearly business revenue, 2010-2030

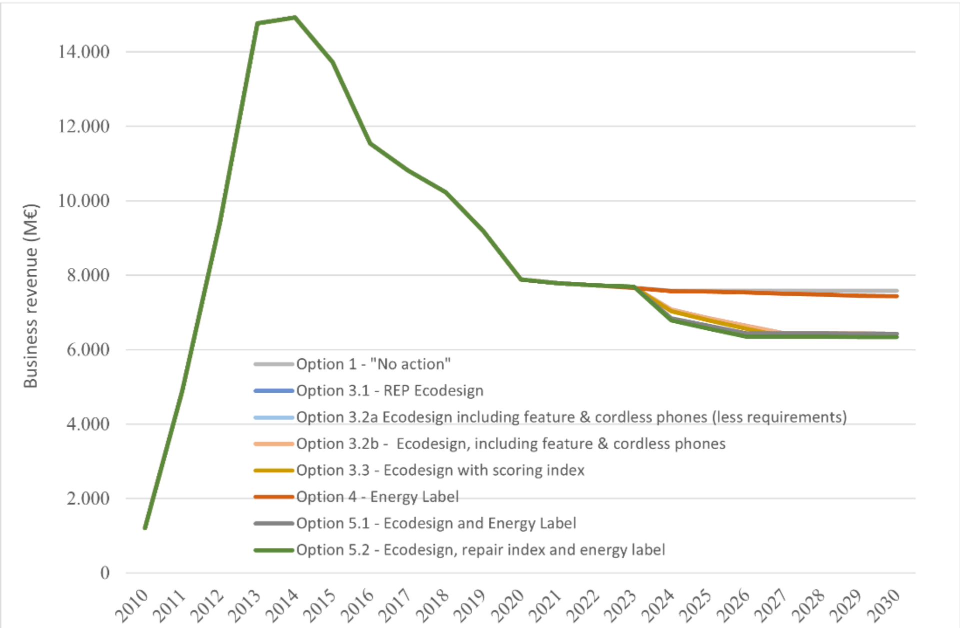


Tablets

Business revenues for *tablets* under the different policy options are depicted in Figure 36. To estimate revenues, the purchase prices of tablets estimated in European Commission (2021) have been used and adapted to the different options (see Table 36). The purchase price in 2030 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 and 3.3*), and for *Option 4* (Energy label) the purchase price is EUR 331. The price in sub-o*ption 5.1* and *5.2* is also EUR 334.

For tablets, business revenue declines by almost EUR 1,150 million under all options, except for *Option 4* (EUR 144 million) in 2030.

Figure 36: Tablets – Yearly business revenue, 2010-2030

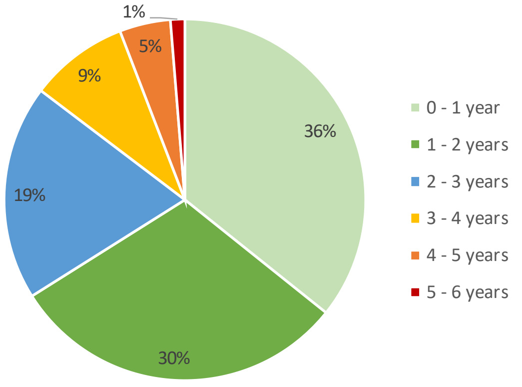


Again, all options including Ecodesign requirements would imply the biggest reduction: EUR 1,150 million on business revenue under sub-o*ptions 3.1*, *5.1* and *3.2a*, and a reduction of EUR 1,240 million for *sub-options 3.3* and *5.2*, as consequence of the main decline on sales.

ENVIRONMENTAL IMPACTS

Figure 37 shows the age structure of active smartphone batteries in 2016 as an approximation for the age structure of smartphones in active use.

Figure 37: age structure of smartphones in active use ((Clemm et al. 2016b)



Starting from the above baseline, environmental improvements will 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 dominating effect of lifetime extending measures, regarding the various domains repair, reuse and reliability, is an anticipated decline in new sales and related environmental impacts stemming from production, but also to a certain extent from shipping devices from the manufacturing location to the EU market. The decline in sales already factors in that a substantial share of consumers upgrades to new devices due to psychological obsolescence and not due to defects or similar design related aspects. Given that most of the environmental impacts are related to device production and to a lesser extent to the use phase, contrary to other energy-related products, extended product lifetime involves only a minor component of keeping less efficient devices in operation for longer periods of time.

Even with a short transition period until measures take effect, environmental improvements materialise at large only around 2027 when the lifetime extending effect of better reparability, reusability and reliability leads to longer product lifetimes and a reduction in replacement sales.

Information requirements regarding production and distribution related environmental parameters, such as emissions of fluorinated greenhouse gases and means of transportation, as foreseen by the generic ecodesign requirements are expected to stimulate improvements in emission reductions, which results in marginal increased life cycle costs for the consumer compared to the life cycle costs level reached by lifetime extending measures only, but which corresponds still to least life cycle costs in terms societal life cycle costs (European Commission 2021).

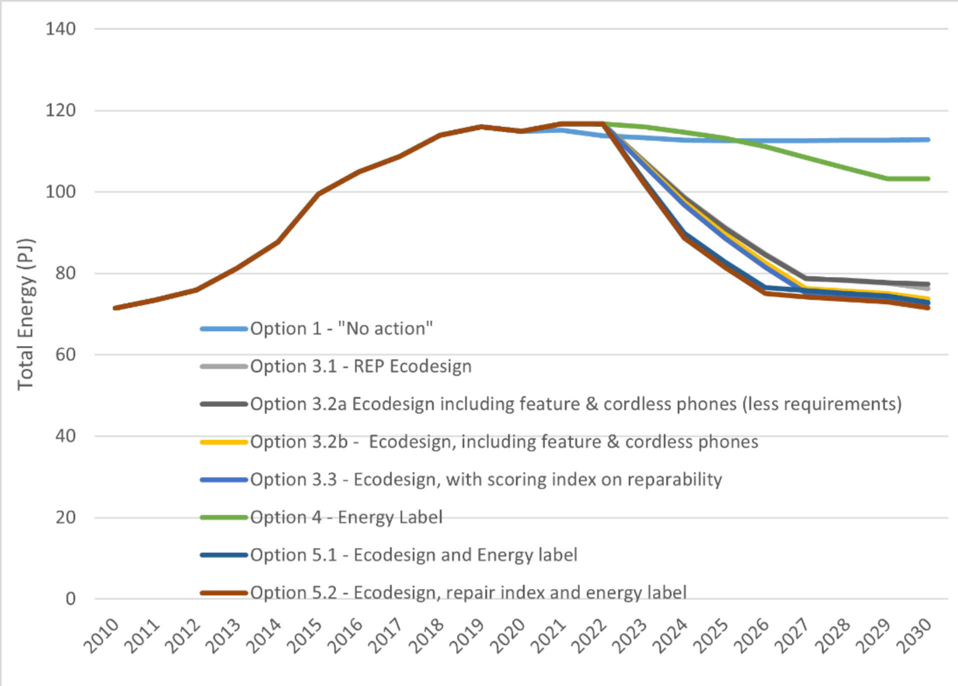
In general, all measures which increase to product lifetime (enhanced reparability, durability in Options 3.1, 3.2a, 3.2b, 3.3, 5.1 and 5.2) result mainly in production related environmental savings outside the EU (but greenhouse gas emissions being a global environmental issue), transports related savings due to less products to be shipped partially relating to logistics outside the EU and partially within the EU, and reduced electronics waste (fewer products discarded) within the EU. Measures targeting at the energy efficiency of devices (covered by information requirements in Options 3.1, 3.2a, 3.2b, 3.3, and more prominently depicted with the Energy Label in Options 4, 5.1 and 5.2) result in environmental and cost benefits within the EU.

I. Energy savings

Smartphones, feature phones and cordless phones

Figure 38 shows the development of energy consumption of *smartphones, feature phones and cordless phone*s under the different policy options and considering their total life cycle (production, distribution and use phase). The graph indicates that total **energy consumption** is reduced significantly by 2030 (roughly 40 PJ) with options involving ecodesign requirements (i.e., sub-o*ptions 3.1*, *3.2a*, *3.2b* and *5.1*) and those sub-options combined with a repair index (i.e. *sub-option 3.3* and *sub-option 5.2*). Energy consumption declines by 10 PJ with *Option 4*. In all cases, savings are driven by technology improvements and extension of the use lifetime of devices.

Figure 38: Smartphones, feature and cordless phones. Yearly total energy 2010-2030

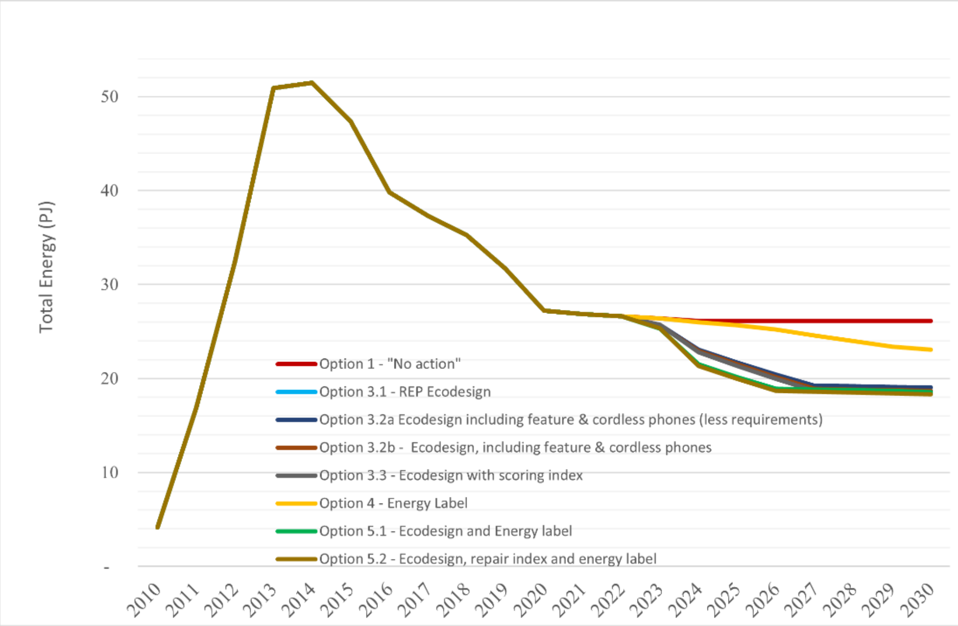


Over 50% of total energy consumption for smartphones sold in 2030 relates to the **production phase** under all policy options. As the majority of manufacturers are located outside the EU, most impacts related to the production phase occur outside the EU. The **use phase** is responsible for 31% (Energy Label option) to 40% (Ecodesign, and Ecodesign plus Energy Label policy) of total energy consumption. This consumption can be attributed to the EU. The **distribution phase** accounts for 7% (*sub-option 5.1*) to 14% (*Option 4*) of total energy consumption. These impacts can be attributed to both EU and non-EU countries.

Tablets

Figure 39 shows the development of life cycle energy consumption for *tablets* under the different policy options. 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. As with phones, total **energy consumption** decreases significantly with options involving ecodesign requirements. With Energy Label scenario (*Option 4*) energy consumption will be reduced to 23 PJ in 2030. The potential energy under sub-*options 3.1*, *3.2a* and *5.1* would be 19 PJ by 2030, being 18 PJ under *sub-option 5.2*.

Figure 39: Tablets. Yearly total energy, 2010-2030



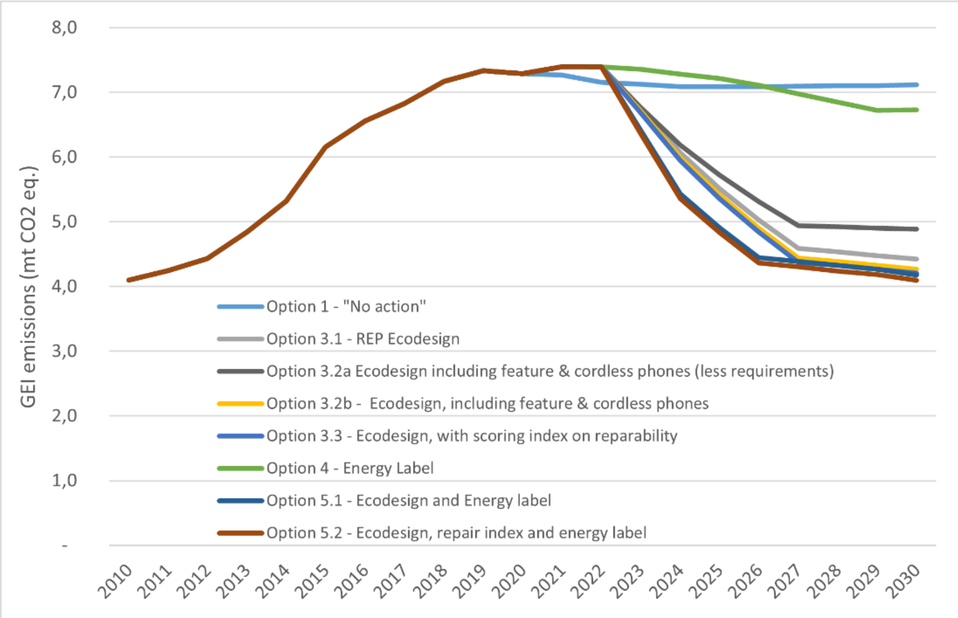
Over 50% of total energy consumption for tablets sold in 2030 relates to the **production phase** under all policy options. The **use phase** is responsible for 33% (Energy Label option) to 40.5% (Ecodesign, and Ecodesign plus energy label policy) of total energy consumption. The **distribution phase** accounts for approximately 7% (*sub-option 5.1*) to 12% (*Option 4*) of total energy consumption.

II. GHG emissions and acidification

Smartphones, feature phones and cordless phones

The trends for greenhouse gas (GHG) emissions are depicted on Figure 40. Under no action, GHG emissions in 2020 and 2030 are estimated at 7.3 and 7.1 million t CO2 eq, respectively. With sub-o*ptions 3.1* (Ecodesign requirements), *5.1* (Ecodesign requirements and Energy Label) and those including a repair index as well (i.e. *3.3* and *5.2*) the Greenhouse Gas emissions drop significantly from 2023 onwards. For these scenarios, the related emissions are 2.7 to 2.9 million t CO2 eq. lower in 2030 than with "no action" (over 40% reduction). Under *sub-option 3.2a*, savings are about 31%, and higher for *sub-option 3.2b* (40%). *Option 4* (Energy Label) reduces Greenhouse Gas emission but to a lesser extent 5%.

Figure 40. Smartphones, feature and cordless phones. Yearly Greenhouse Gas Emissions, 2010-2030 (in Mt CO2 equivalent)

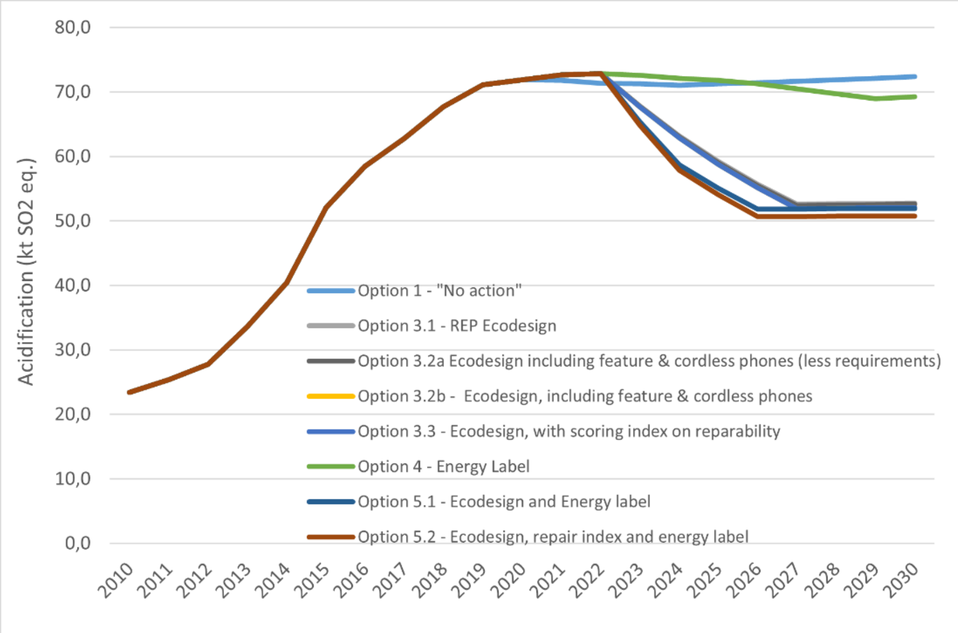


Over 58% of total greenhouse gas emissions for devices sold in 2030 relates to the **production phase** under all scenarios. The **use phase** is responsible for 24% (no action scenario) to 31% (Ecodesign and Energy label scenarios) of total greenhouse gas emissions. The **distribution phase** accounts for 10% (*sub-option 5.1*) to 17% (*Option 1*) of total greenhouse gas emissions.

The same trends are confirmed for **acidification** under the different policy scenarios (Figure 41). Acidification is related to the SO2 emissions coming from production, use, distribution and end-of-life phases of devices, mainly related to electricity use. That one with the greatest contribution is production phase, while end-of-life stage presents the capacity to absorb SO2 emissions, especially from recycling.

Sub-o*ptions 3.1* (Ecodesign requirements), *5.1* (Ecodesign requirements and Energy Label), *3.2a and 3.2b* (Extended Ecodesign options), *3.3* and *5.2* (with repair index) result in significant reductions in SO2 and other emissions contributing to acidification. Roughly 20 kt SO2 eq. reduction for 2030 (over 28%). Actually, a similarly high savings potential is achieved already from 2027 onwards in these scenarios. *Option 4* (Energy Label) results in less emissions reduction (3 kt SO2 eq. (4%).

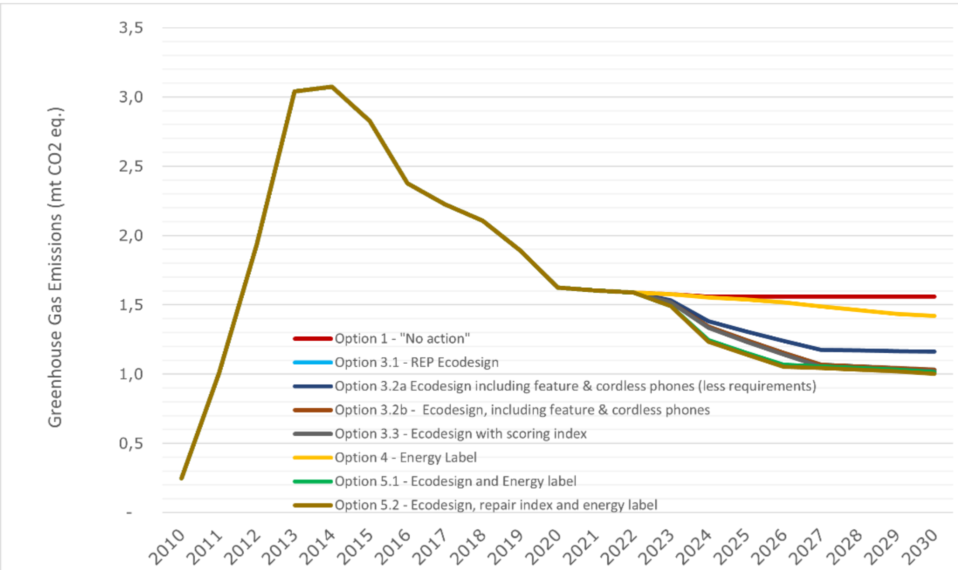
Figure 41. Smartphones, feature and cordless phones. Yearly acidification, 2010-2030 (in kt SO2 equivalent)



Tablets

With sub-o*ptions 3.1* (Ecodesign requirements), *3.2a* (less ambitious ecodesign option) and *5.1* (Ecodesign requirements plus Energy Label) and those including a scoring on reparability (i.e. *sub-option 3.3* and *5.2*) the Greenhouse Gas emissions drop significantly from 2023 onwards (Figure 42). For these scenarios, the related emissions decrease respectively: 34%, 25%, 35%, 35% and 36% in 2030 in comparison with "no-action". The saving potential of Energy Label (i.e., *Option 4*) is only 9%.

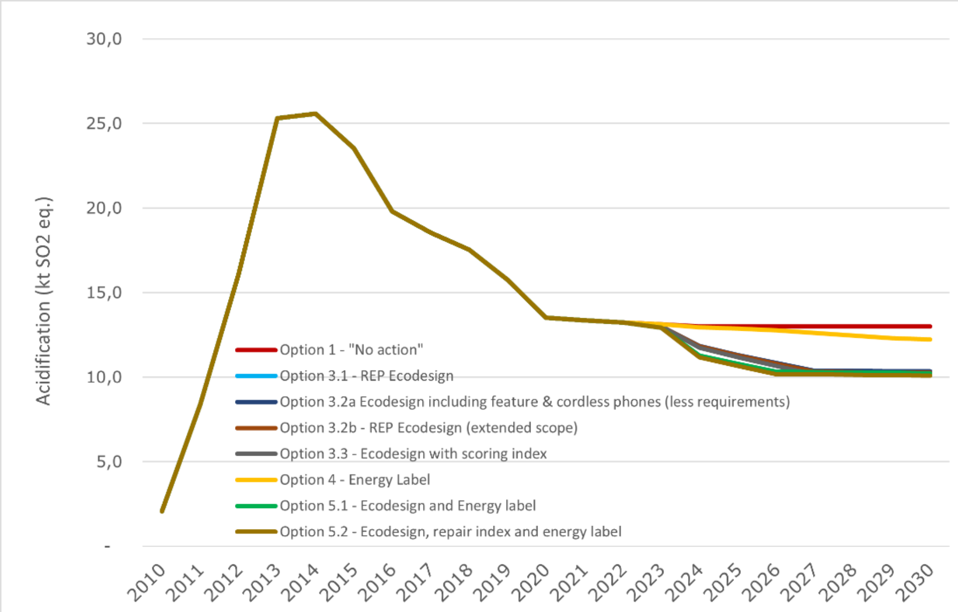
Figure 42: Tablets. Yearly Greenhouse Gas Emissions, 2010-2030 (in Mt CO2 equivalent)



The same trends for the various policy scenarios are confirmed for **acidification** (Figure 43). Sub-o*ptions 3.1* (Ecodesign requirements), *3.2a* (less ambitious ecodesign option) *5.1*

(Ecodesign requirements and Energy Label) and specifically for *sub-options* (i.e. *3.3* and *5.2*) result in significant reductions in SO2 and other emissions contributing to acidification. This is a reduction in 2030 of 21% for the first ones, and 22% for the second ones. Actually, a similarly high savings potential is achieved already from 2027 onwards in these scenarios. *Option 4* (Energy Label) results in less emissions reductions (6%).

Figure 43: Tablets. Yearly acidification, 2010-2030 (in kt SO2 equivalent)



III. Circular economy perspective: material consumption

In the case of *sub-option 3.3*, products with a longer lifespan are[1,2] expected to contribute to circular economy through reduction in impacts related to resource depletion, waste, emissions, and other environmental costs associated with the production, distribution, and

[1] Iraldo et al. (2017) Is product durability better for environment and for economic efficiency? A comparative assessment applying LCA and LCC to two energy-intensive products. Journal of Cleaner Production; Ardente and Mathieux (2014) Environmental assessment of the durability of energy-using products: method and application. Journal of cleaner production; and Reale et al. (2019) Consumer Footprint-Basket of Products indicator on Household appliances. Technical report. European Commission, Joint Research Centre. 2019.

2 The results of a JRC study showed that, *"for the global warming potential, prolonging the lifetime of a washing machine and dishwasher case studies is environmentally beneficial when the potential replacement product has up to 15 % less energy consumption during the use. For the abiotic depletion potential impact, mainly influenced by the use of materials during the production phase, prolonging the lifetime of both machines was shown always to be beneficial, regardless of the energy efficiency of newer products. Freshwater eutrophication showed a great influence by the impact of the detergent used during the use phase; thus, prolonging the device's lifetime is still beneficial for this impact category, although the benefits are negligible compared to the life cycle impacts of the products."* See https://op.europa.eu/en/publication-detail/-/publication/72cd56e4-bab7-11e6-9e3c-01aa75ed71a1/language-en/format-PDF/source-126402524

disposal life-cycle stages[3,4,5,6,7]. For example, a German Environment Agency study[8] concluded that for all product groups examined, long-life products did better than short-life variants in all environmental categories. Similarly, the PROMPT project shows that, for all the appliances analysed, those with shorter lives always perform worse for all environmental indicators.[9] According to Defra[10], there is an argument in particular for optimised lifetime extension strategies, especially for products in which manufacturing, supply chain and waste management impacts dominate over the life cycle. According to a European Environmental Bureau (EEB) study (2019), extending the lifespan of all washing machines, smartphones, laptops, and vacuum cleaners in the EU by one year would lead to annual savings of around 4 million tonnes of carbon dioxide by 2030. In addition, it can promote the reuse of goods by providing more certainty regarding the remaining lifespan after first use.

There will also be positive environmental impacts because the products will have a longer lifetime and thus be less frequently replaced, and the potential for circularity (i.e., re-sale and reuse)[11] is increased by measures under this option. Other indirect positive environmental impacts are expected because avoiding early failure of products prevents their early replacement and therefore reduces environmental impacts related to the production, transport, and disposal of products.

As consumer behaviour is a significant factor in the case of these products, the minimum requirements will lead to choice editing (using policy measures to restrict the choices and push consumers towards more sustainable options) and thus bring environmental benefits. Overall, the environmental benefits of including a scoring on reparability would be significant.[12] This will increase those resulting from Ecodesign requirements and Energy label, making sub-option 5.2 the most ambitious.

Smartphones, feature phones and cordless phones

Total **material consumption** of which *smartphones, feature phones and cordless phones*, accessories and packaging sold in 2030 are made is calculated to be roughly 86,000 t[13] with *Option 1* (Table 37). Total material consumption is reduced under all options: 32%

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[3] Estevan et al.(2017) Life Cycle Costing State of the art report. Local Governments for Sustainability, European Secretariat
[4] Bakker et al. (2014) Products that go round: Exploring product life extension through design. J Clean Prod
[5] Bakker et al. (2019) Products that Last 2.0: Product Design for Circular Business Models. BIS Publishers
[6] Cooper (2016) Longer lasting products: Alternatives to the throwaway society. CRC Press
[7] Ruth et al. (2005) Design Strategies to Postpone Consumers' Product Replacement: The Value of a Strong Person-Product Relationship, The Design Journal
[8] Prakash et al. (2016) Einfluss der Nutzungsdauer von Produkten auf ihre Umweltwirkung: Schaffung einer Informationsgrundlage und Entwicklung von Strategien gegen „Obsoleszenz ". Dessau-Roßlau: UBA Texte
[9] Berwald et al.(2020) Environmental evaluation of current and future design rules. PROMPT
[10] Defra (2011) Longer Product Lifetimes – Summary Report
[11] EEA(2017) Circular by design – Products in the circular economy
[12] Donati et al. (2020) indicate some of these circular economy measures result in reduction of several environmental indicators: −10.1% Global Warming Potential,−12.5% Raw Material Extraction (RME),−4.3% Land Use (LU) and−14.6% Blue Water Withdrawal (BWW).
[13] This includes part of the metal production waste from machining housing parts and spare parts which will be used for repairs of these units over their lifetime.

(*sub-option 3.1*), 31% (*sub-option 3.2a*), 36% (*sub-option 3.2b*), 1% (*Option 4*), and 37% (*sub-option 5.2*). The consumption of **Critical Raw Materials** also decreases along with the declining sales. The amount of Tantalum is reduced from 3.9 t in the "no action" scenario to 3.0 t with sub-o*ptions 3.1* (Ecodesign requirements) and *5.1* (Ecodesign requirements and Energy Label). Same trends can be observed for the other Critical Raw Materials. Figures for sub-*sub-options 3.3* and *5.2* are not available, but expected to be at least as good in terms of material reduction as those of *sub-options 3.2* and *5.1*.

Table 37: Smartphones, feature phones and cordless phones. Annual material consumption, all units sold in 2030

2030: smartphones + feature phone + cordless phone	Option 1 - "No action"	Option 3.1 - REP Ecodesign	Option 3.2a Ecodesign including feature & cordless phones (less requirements)	Option 3.2b - Ecodesign, including feature & cordless phones	Option 3.3 - Ecodesign, with scoring index on reparability	Option 4 - Energy Label	Option 5.1 - Ecodesign and Energy label	Option 5.2 - Ecodesign, repair index and energy label
Material categories								
Bulk Plastics (t)	4168	3432	3269	2960	< 2960	4137	2938	< 2938
TecPlastics (t)	7840	4928	5052	4612	< 4612	7828	4483	< 4483
Ferro metals (t)	2464	1831	1896	1800	< 1800	2416	1794	< 1794
Non-ferro metals (t)	14370	10531	11215	10354	< 10354	14024	10309	< 10309
Electronics (t)	18693	13587	13921	13198	< 13198	18361	13106	< 13106
Miscellaneous, mainly paper, cardboard	38947	24350	23934	22688	< 22688	38785	22047	< 22047
Totals materials (t)	**86482**	**58659**	**59288**	**55613**	**< 55613**	**85551**	**54677**	**< 54677**
thereof, Critical Raw Materials (t)	-	-		-		-	-	-
Tantalum (Ta)	4	3	3	3	< 3	4	3	< 3
Indium (In)	1	1	1	1	< 1	1	1	< 1
Platinum Group metals (PGM)	2	1	1	1	< 1	2	1	< 1
Gallium (Ga)	0	0	0	0	0	0	0	0
Rare earth elements (Sc, Y, Nd)	17	14	13	13	< 13	17	13	< 13
Cobalt (Co)	855	655	646	648	< 648	835	648	< 648
Magnesium (Mg)	746	560	558	560	< 560	728	560	< 560

Tablets

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[14] (Table 38). Total material consumption is reduced under all options: 27% (*sub-option 3.1*and *3.2a*), 2% (*Option 4*) and 28% (*sub-option 5.1*). The consumption of Critical Raw Materials, provided that the composition of tablets is also reduced along with the declining sales of devices. For example, the amount of Tantalum is reduced from 0.9 t in the no action option to 0.8 t with sub-o*ption 3.1* (Ecodesign requirements) and *5.1* (Ecodesign requirements and Energy Label). Same trends can be observed for the other Critical Raw Materials. Again, figures for *sub-options 3.3* and *5.2* are not available but expected to be at least as good in terms of material reduction as those of *sub-options 3.1* and *5.1*.

[14] This also includes part of the metal production waste from machining housing parts and spare parts which will be used for repairs of these units over their lifetime.

Table 38: Tablets. Annual material consumption, all units sold in 2030

2030: Tablet	Option 1 - "No action"	Option 3.1 - REP Ecodesign	Option 3.2a Ecodesign including feature & cordless	Option 3.2b - Ecodesign, including feature & cordless phones	Option 3.3 - Ecodesign, with scoring index on reparability	Option 4 - Energy Label	Option 5.1 - Ecodesign and Energy label	Option 5.2 - Ecodesign, repair index and energy label
Material categories								
Bulk Plastics (t)	1125	733	800	733	< 733	1101	715	< 715
TecPlastics (t)	1690	1034	1112	1034	< 1034	1653	1002	< 1002
Ferro metals (t)	487	374	373	374	< 374	476	371	< 371
Non-ferro metals (t)	5916	4892	4888	4892	< 4892	5786	4883	< 4883
Electronics (t)	5479	4272	4265	4272	< 4272	5359	4245	< 4245
Miscellaneous, mainly paper, cardboard (t)	15726	10871	10853	10871	< 10871	15382	10679	< 10679
Totals materials (t)	**30423**	**22176**	**22292**	**22176**	< 22176	**29757**	**21894**	< 21894
thereof, Critical Raw Materials (t)								
Tantalum (Ta)	0,9	0,8	0,8	0,8	< 0,8	0,9	0,8	< 0,8
Indium (In)	0,5	0,4	0,4	0,4	< 0,4	0,4	0,4	< 0,4
Platinum Group metals (PGM)	0,2	0,2	0,2	0,2	< 0,2	0,2	0,2	< 0,2
Gallium (Ga)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Rare earth elements (Sc, Y, Nd)	17,2	14,4	14,4	14,4	< 14,4	16,8	14,4	< 14,4
Cobalt (Co)	344	289	288	289	< 289	337	289	< 289
Magnesium (Mg)	459	385	384	385	< 385	449	385	< 385

IV. Risks related to excess spare parts inventory

Given the relevance of the requirements on reparability (under the policy options 3.1, 3.2a, 3.2b, 3.3, 5.1, 5.2), and in particular of those related to spare parts availability, some further considerations are necessary, in particular concerning the estimation of the associated environmental impacts.

In first place, it should be noted that the environmental aspects have been already taken into account in the definition of the list of components, which should be available as spare parts (as described with more detail under annex 9). In fact, this list is already the results of a 'trade-off' between the need of including the components that are more prone to fail, and their environmental impacts. This led, in particular, to the exclusion from this list of the mainboard (as explained in Table 20 of annex 9, the mainboard components are those with the highest environmental impacts, which are accounted for when assessing the policy options with increased reparability).

As a second consideration, the requirement of providing spare parts for a given period of time (Options 3.1, 3.2a, 3.2b, 3.3, 5.1, 5.2) involves the risk that spare parts are produced but might not be needed in the end, i.e. being obsolete stock. This obsolete stock inventory is related to additional environmental impacts and costs. The requirements however target at minimizing this risk: From the list spare parts the mainboard is exempted as it represents a significant upstream environmental impact. All other components individually represent maximum 10% (display) of the environmental impact of the device. The amount of the stock inventory depends on thorough planning by the manufacturers: for all spare parts, except for batteries, it is assumed that defects occur at roughly constant failure rates after the initial phase of early failures is passed. Spare parts demand over time will provide manufacturers therefore with sound insights in field failure rates and allows for demand forecasts. Manufacturers also have various options to counter potential overstock, including

- platform designs, where parts can be used also for next product generations (see e.g. the fact, that among iPhones some parts are compatible with different models),
- providing spare parts beyond the minimum required period,
- harvest used devices for spare parts (in case of underestimating demand).

Given the short required delivery time of 5 days for spare parts, these parts have to be on stock, presumably in the EU, to be readily available for orders.

A sensitivity analysis provides insights in potential negative effects resulting from overstock. This has been calculated for the 6 product segments entry-level smartphones, mid-range smartphones, high-end smartphones, feature phones, cordless phones and tablets, with the assumption that the obsolete overstock varies between 10% and 50% of the actual spare parts demand. Obsolete stock here refers to the hypothetical case that an OEM puts on stock 10% to 50% more spare parts units than actually will be required and ordered for repairs. This practice might be due to an approach by the OEM to be on the safe side to be in compliance with the requirement to supply spare parts for a given period of time and/or due to false forecasts of spare parts needs. This overstock is allocated to individual devices according to the expected actual demand of spare parts per product. As not every product will experience a defect, for average products only a given share of a spare part is allocated. The changes in environmental impacts are listed in Table 39 for entry-level smartphones.

Table 39: Impacts of excess spare parts stock – entry-level smartphones

Entry-level smartphone							
Excess spare parts production (factor)		**1**	**1,1**	**1,2**	**1,3**	**1,4**	**1,5**
Other Resources & Waste							
Total Energy (GER)	MJ	413,9	414,1	414,3	414,4	414,6	414,8
of which, electricity (in primary MJ)	MJ	298,1	298,2	298,4	298,5	298,6	298,7
Water (process)	ltr	197,1	197,2	197,3	197,4	197,5	197,6
Water (cooling)	ltr	101,6	101,6	101,6	101,6	101,7	101,7
Waste, non-haz./ landfill	g	1946,9	1947,0	1947,2	1947,3	1947,5	1947,6
Waste, hazardous/ incinerated	g	137,0	137,0	137,0	137,1	137,1	137,2
Emissions (Air)							
Greenhouse Gases in GWP100	kg CO2 eq.	21,36	21,37	21,38	21,39	21,40	21,42
Acidification, emissions	g SO2 eq.	242,0	242,1	242,1	242,2	242,2	242,3
Volatile Organic Compounds (VOC)	g	8,68	8,69	8,70	8,71	8,72	8,72
Persistent Organic Pollutants (POP)	ng i-Teq	1,18	1,18	1,18	1,18	1,18	1,18
Heavy Metals	mg Ni eq.	284,8	284,9	285,0	285,0	285,1	285,2
PAHs	mg Ni eq.	2,33	2,33	2,33	2,33	2,33	2,33
Particulate Matter (PM, dust)	g	8,82	8,82	8,83	8,83	8,84	8,84
Emissions (Water)							
Heavy Metals	mg Hg/20	856,7	857,1	857,5	857,9	858,3	858,7
Eutrophication	g PO4	11,44	11,45	11,47	11,48	11,49	11,50

Even if the excess stock reaches a level of 50% of actually needed spare parts, the environmental impacts per device are only slightly higher: the total energy demand and actually all other impacts rise by approximately only 0,25%.

Similar trends can be observed for the other product segments: In the case of mid-range smartphones environmental impacts increase by approximately 0,6%, if an obsolete stock of 50% on top of the real demand is envisaged (results for excess spare parts factor 1,5 in Table 40).

Table 40: Impacts of excess spare parts stock – mid-range smartphones

Mid-range smartphone							
Excess spare parts production (factor)		**1**	**1,1**	**1,2**	**1,3**	**1,4**	**1,5**
Other Resources & Waste							
Total Energy (GER)	MJ	605,4	606,1	606,8	607,5	608,2	608,9
of which, electricity (in primary MJ)	MJ	476,2	476,4	476,6	476,8	477,1	477,3
Water (process)	ltr	314,5	314,7	314,9	315,2	315,4	315,6
Water (cooling)	ltr	170,3	170,3	170,3	170,3	170,3	170,3
Waste, non-haz./ landfill	g	3253,6	3254,5	3255,5	3256,4	3257,3	3258,2
Waste, hazardous/ incinerated	g	241,4	241,4	241,5	241,6	241,6	241,7
Emissions (Air)							
Greenhouse Gases in GWP100	kg CO2 eq.	29,68	29,72	29,77	29,82	29,9	29,9
Acidification, emissions	g SO2 eq.	400,7	401,0	401,3	401,5	401,8	402,0
Volatile Organic Compounds (VOC)	g	14,07	14,15	14,23	14,32	14,40	14,49
Persistent Organic Pollutants (POP)	ng i-Teq	2,42	2,42	2,42	2,42	2,42	2,42
Heavy Metals	mg Ni eq.	502,3	502,8	503,2	503,6	504,1	504,5
PAHs	mg Ni eq.	8,88	8,88	8,88	8,88	8,88	8,88
Particulate Matter (PM, dust)	g	14,15	14,18	14,21	14,24	14,27	14,30
Emissions (Water)							
Heavy Metals	mg Hg/20	1417,9	1421,0	1424,1	1427,3	1430,4	1433,5
Eutrophication	g PO4	18,87	18,92	18,97	19,02	19,06	19,11

In the case of high-end smartphones environmental impacts increase by approximately 0,75%, if an obsolete stock of 50% on top of the real demand materialises (Table 41). In case of greenhouse gas emissions, to pick an exemplary indicator, this means an increase of close to 500g of CO_2 eq. compared to 45,57 kg CO_2 eq. greenhouse gas emissions over the full life cycle, if the spare parts stock exactly meets forecasted demand.

Table 41: Impacts of excess spare parts stock – high-end smartphones

High-end smartphone							
Excess spare parts production (factor)		**1**	**1,1**	**1,2**	**1,3**	**1,4**	**1,5**
Other Resources & Waste							
Total Energy (GER)	MJ	908,4	909,8	911,2	912,6	914,0	915,4
of which, electricity (in primary MJ)	MJ	720,3	720,6	720,9	721,2	721,4	721,7
Water (process)	ltr	433,7	434,0	434,4	434,7	435,0	435,3
Water (cooling)	ltr	287,8	287,8	287,8	287,8	287,8	287,8
Waste, non-haz./ landfill	g	5102,8	5104,8	5106,8	5108,8	5110,9	5112,9
Waste, hazardous/ incinerated	g	420,0	420,1	420,1	420,2	420,3	420,4
Emissions (Air)							
Greenhouse Gases in GWP100	kg CO2 eq.	45,57	45,67	45,76	45,85	45,94	46,04
Acidification, emissions	g SO2 eq.	668,9	669,4	669,9	670,5	671,0	671,5
Volatile Organic Compounds (VOC)	g	21,54	21,73	21,92	22,11	22,30	22,49
Persistent Organic Pollutants (POP)	ng i-Teq	2,72	2,72	2,72	2,73	2,73	2,73
Heavy Metals	mg Ni eq.	870,0	870,9	871,8	872,7	873,6	874,5
PAHs	mg Ni eq.	10,79	10,81	10,83	10,85	10,88	10,90
Particulate Matter (PM, dust)	g	21,41	21,47	21,54	21,60	21,67	21,74
Emissions (Water)							
Heavy Metals	mg Hg/20	2211,3	2218,0	2224,8	2231,5	2238,3	2245,1
Eutrophication	g PO4	28,51	28,61	28,71	28,81	28,91	29,01

In the case of feature phones environmental impacts increase by approximately 0,55%, if an obsolete stock of 50% on top of the real demand materialises (Table 42). In case of greenhouse gas emissions, to pick an exemplary indicator, this means an increase of close to 70g of CO_2 eq. compared to 12,99 kg CO_2 eq. greenhouse gas emissions over the full life cycle, if the spare parts stock exactly meets forecasted demand.

Table 42: Impacts of excess spare parts stock – feature phones

Feature phone							
Excess spare parts production (factor)		**1**	**1,1**	**1,2**	**1,3**	**1,4**	**1,5**
Other Resources & Waste							
Total Energy (GER)	MJ	253,0	253,2	253,4	253,6	253,8	254,0
of which, electricity (in primary MJ)	MJ	168,5	168,6	168,6	168,6	168,6	168,7
Water (process)	ltr	117,9	118,0	118,1	118,2	118,3	118,3
Water (cooling)	ltr	32,1	32,1	32,1	32,1	32,1	32,1
Waste, non-haz./ landfill	g	1092,8	1093,1	1093,5	1093,8	1094,2	1094,5
Waste, hazardous/ incinerated	g	24,8	24,8	24,8	24,8	24,8	24,8
Emissions (Air)							
Greenhouse Gases in GWP100	kg CO2 eq.	12,99	13,00	13,02	13,03	13,05	13,06
Acidification, emissions	g SO2 eq.	81,0	81,1	81,1	81,2	81,3	81,4
Volatile Organic Compounds (VOC)	g	5,19	5,22	5,25	5,28	5,31	5,34
Persistent Organic Pollutants (POP)	ng i-Teq	0,81	0,81	0,81	0,81	0,81	0,81
Heavy Metals	mg Ni eq.	58,1	58,2	58,4	58,5	58,7	58,8
PAHs	mg Ni eq.	2,03	2,03	2,03	2,03	2,03	2,03
Particulate Matter (PM, dust)	g	3,97	3,98	3,99	4,01	4,02	4,03
Emissions (Water)							
Heavy Metals	mg Hg/20	410,6	411,9	413,2	414,6	415,9	417,2
Eutrophication	g PO4	5,76	5,78	5,79	5,81	5,83	5,85

For cordless phones excess stock of spare parts is not an issue as the most relevant part to be replaced among cordless phones are batteries and the requirements specify the use of standard battery sizes, i.e. spare parts needs can always be met by providing batteries freely available on the market.

Table 43: Impacts of excess spare parts stock – cordless phones

Cordless phone							
Excess spare parts production (factor)		**1**	**1,1**	**1,2**	**1,3**	**1,4**	**1,5**
Other Resources & Waste							
Total Energy (GER)	MJ	332,5	not relevant				
of which, electricity (in primary MJ)	MJ	199,1					
Water (process)	ltr	94,5					
Water (cooling)	ltr	47,7					
Waste, non-haz./ landfill	g	494,9					
Waste, hazardous/ incinerated	g	22,8					
Emissions (Air)							
Greenhouse Gases in GWP100	kg CO2 eq.	18,12					
Acidification, emissions	g SO2 eq.	102,8					
Volatile Organic Compounds (VOC)	g	4,55					
Persistent Organic Pollutants (POP)	ng i-Teq	1,27					
Heavy Metals	mg Ni eq.	45,0					
PAHs	mg Ni eq.	6,13					
Particulate Matter (PM, dust)	g	6,66					
Emissions (Water)							
Heavy Metals	mg Hg/20	256,0					
Eutrophication	g PO4	4,19					

In the case of tablets environmental impacts increase by approximately 0,8%, if an obsolete stock of 50% on top of the real demand materialises (Table 44).

Table 44: Impacts of excess spare parts stock – tablets

Slate tablet							
Excess spare parts production (factor)		**1**	**1,1**	**1,2**	**1,3**	**1,4**	**1,5**
Other Resources & Waste							
Total Energy (GER)	MJ	796,1	797,4	798,7	800,0	801,3	802,6
of which, electricity (in primary MJ)	MJ	592,2	592,7	593,2	593,7	594,2	594,7
Water (process)	ltr	400,5	400,9	401,2	401,6	401,9	402,3
Water (cooling)	ltr	161,1	161,1	161,1	161,1	161,1	161,1
Waste, non-haz./ landfill	g	3558,2	3560,1	3561,9	3563,8	3565,6	3567,5
Waste, hazardous/ incinerated	g	221,3	221,5	221,6	221,8	222,0	222,1
Emissions (Air)							
Greenhouse Gases in GWP100	kg CO2 eq.	38,23	38,32	38,41	38,50	38,59	38,68
Acidification, emissions	g SO2 eq.	403,8	404,3	404,8	405,2	405,7	406,1
Volatile Organic Compounds (VOC)	g	18,80	18,94	19,08	19,21	19,35	19,49
Persistent Organic Pollutants (POP)	ng i-Teq	3,81	3,81	3,81	3,81	3,82	3,82
Heavy Metals	mg Ni eq.	472,9	473,7	474,4	475,2	476,0	476,8
PAHs	mg Ni eq.	13,21	13,22	13,23	13,25	13,26	13,27
Particulate Matter (PM, dust)	g	18,84	18,90	18,95	19,01	19,07	19,13
Emissions (Water)							
Heavy Metals	mg Hg/20	1678,2	1682,9	1687,7	1692,5	1697,3	1702,1
Eutrophication	g PO4	27,86	27,96	28,07	28,17	28,28	28,38

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.

As spare parts, just as the vast majority of all mobile phones and tablets, are produced outside the EU, the resulting additional environmental impacts of obsolete stock would be related to impacts outside the EU. The resulting electronics waste then occurs within the EU.

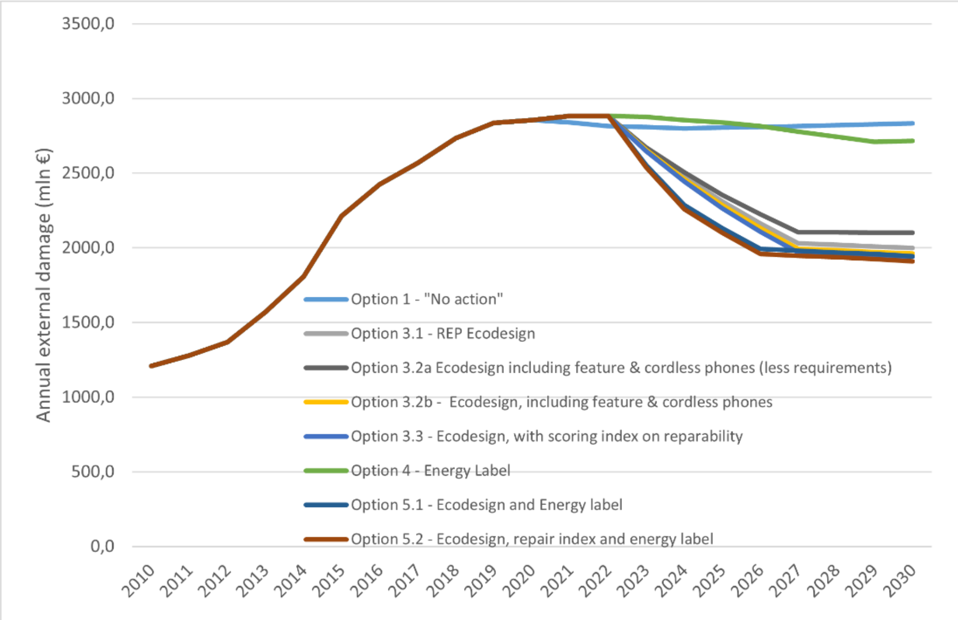
V. External societal costs and benefits

Manufacture of electronic devices has a significant impact over the environment. For this, it is essential to reflect in some way this impact in economic terms and compare how it evolves under different options. Updated societal costs are estimated in the Preparatory Study (2021) under MEErP (2011) methodology, considering some environmental indicators and their rate external marginal cost to society (€/unit).

Smartphones, feature phones and cordless phones

Figure 44 shows the external annual societal damages under different policy options, based on the cost figures introduced in European Commission (2021). With O*ption 4* (Energy Label) social external damages will be reduced by 2030 (EUR 120 million), although the biggest reduction is achieved with those including repair index, *sub-option 3.3 (EUR 895 million)* and *5.2 (EUR 925 million).* The extended ecodesign options, i.e. *sub-option 3.2a and 3.2b* will also imply a significant drop of EUR 730 million and EUR 870 million, respectively. The same for sub-o*ptions 5.1* (EUR 890 million). Sub-o*ption 3.1* reduces external societal costs by almost EUR 830 million in 2030.

Figure 44: Smartphones, feature and cordless phones.
External annual damages evolution, 2010-2030



Tablets

The external annual damages of *tablets* under different policy options are depicted in Figure 45**.** With O*ption 4* (Energy Label), external damages will be reduced by EUR 33 million in 2030. However, a major reduction in external damages is achieved again with sub-o*ption 3.1* (Ecodesign requirements, EUR 144 million), *sub-option 3.2a* (less ambitious ecodesign option, EUR 133 million) and *5.1* (Ecodesign requirements and Energy Label, EUR 149 million) and those including repair index, i.e. *sub-option 3.3 (EUR 149 million)* and *5.2 (EUR 153 million).*

Figure 45: Tablets. External annual damages evolution, 2010-2030