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Towards an Effective Right to Repair for Electronics

Overcoming legal, political and supply barriers to contribute to circular electronics in the EU

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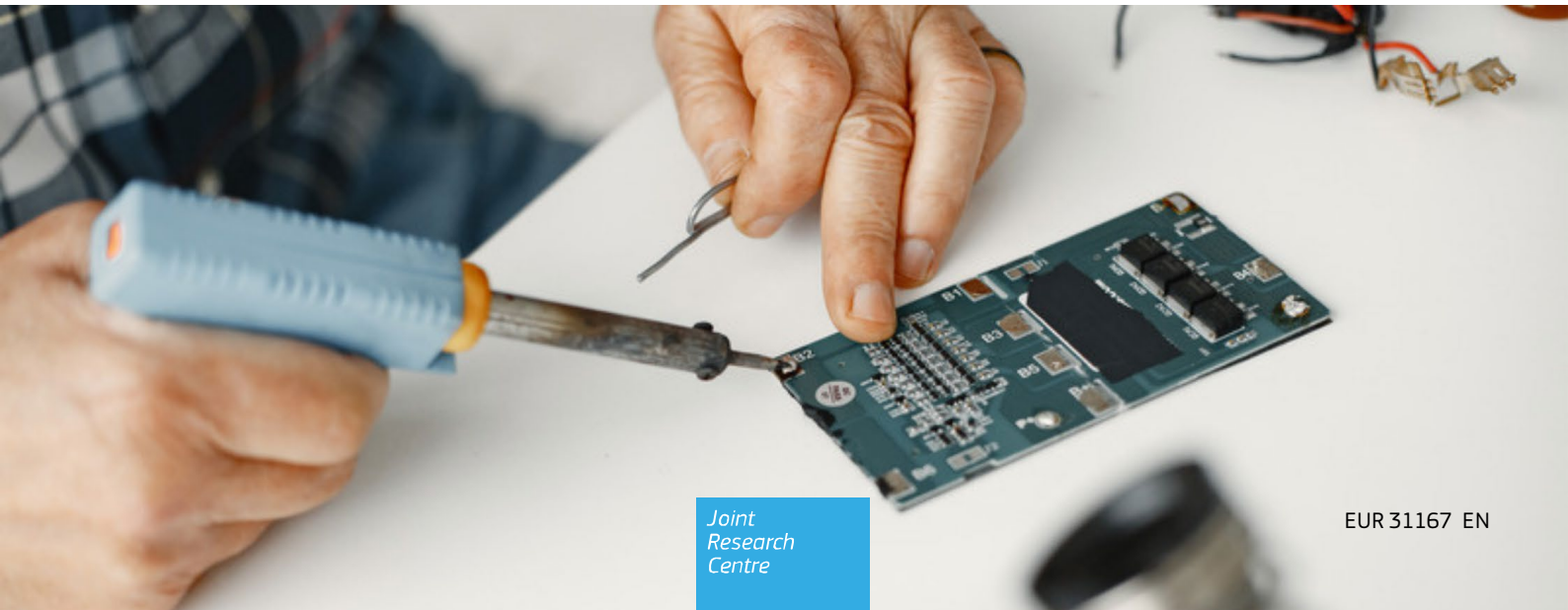

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Contents

Foreword

For want of a shoe the horse was lost.
For want of a horse the rider was lost.
For want of a rider the battle was lost.
For want of a battle the kingdom was lost.
And all for the want of a horseshoe nail.
- Old proverb

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Abstract

Digital technologies are essential for achieving the EU's climate ambitions. At the same time electronic devices and infrastructures carry high environmental and social costs due to their resource intensity, complex global supply chains and the linear nature of the industry. From 485 million smartphones in use in 2010 globally, this number has increased to 6.4 billion in 2021. Electrical and electronic equipment continues to be one of the fastest growing waste streams in the EU, with current annual growth rates of 2%, while it is estimated that less than 40% of electronic waste is recycled in the EU.

The Commission's Circular Electronics Initiative (CEI), as part of the Circular Economy Action Plan (CEAP), will offer a holistic approach to tackling this problem. The report focusses on the Right to Repair as one key aspect of the CEI with a particular emphasis on consumer electronic products, notably smartphones, tablets and laptops.

The report examines the opportunities and challenges of implementing a right to repair for electronic devices at European level. While barriers to repair are of various nature (e.g. technical, social, cultural), the report focuses on legal barriers, on barriers affecting repair supply and on political barriers and enablers. Major challenges arise from IP protection mechanisms leading to restriction in the sharing of repair manuals, digital locks blocking repair or end-user licence agreements (EULAs) and conditioned sales contracts forbidding repair. The potential for growth of the repair of electronic devices sector in Europe has only been partly realised, due to its fragmentation, high costs, a lack of skilled workers, and issues related to consumer trust. Despite powerful social movements, no political Right to Repair for digital devices could be implemented so far, especially due to heavy lobbying efforts from the digital manufacturing industry.

Promoting the repair of digital devices could lead to major environmental benefits. Initial research shows that extending the lifespan of smartphones by just one year in the EU could save GHG emissions equivalent to removing over 1 million cars from EU roads daily. At the same time, extending the lifespan of phones also reduces environmental impacts, such as toxic leaks or biodiversity loss during mining and production processes. In comparison, repair is less energy-intensive than recycling and should be a preferred option.

In addition, improved reparability has significant socio-economic benefits. Extending product lifetimes can lead to reduced costs for consumers, for instance, up to 338€ on smartphones over a period of 4.5 years, with a two-year lifetime extension and self-replacement of battery. More accessible repair would be especially beneficial for marginalised communities. As the repair sector is relatively labour-intensive and local, with low skills entry barriers, promoting repair would create local jobs. Negative impacts on turnover and employment would be concentrated on manufacturers, which are mostly located outside of the EU. From a geopolitical perspective, fostering repair and reuse can reduce the dependence on critical raw materials and chips manufactured abroad.

A set of recommendations looks at elements essential in the implementation of a right to repair. This includes for example more modular designs as well as access to spare parts, tools, repair information and manuals and potential solutions to obtain reparability information upon purchase. Influencing consumer behaviours and preferences with education, communication and nudging, can help promote repair over replacement. The report focuses on recommendations addressing certain legal barriers and to support the supply of repair. To overcome IP barriers, a broad exemption for repair is needed, while at the same time ensuring that existing exemptions are not used against repair. One minimum option would be to make facultative exemptions in the 2001 Copyright Directive obligatory to reach harmonization across member states. In addition, circumventing digital locks should be possible for repair purposes and contracting out of EULAs prohibited. Fiscal incentives to encourage repairs could include lower or no VAT rates for repair services or repair subsidies. Upskilling and reskilling the workforce to ensure the needed technical skills for repair, introducing standards for repairs, extended warranty schemes and setting up national and EU wide networks of repairers could be additional measures to increase repair rates. Finally, innovative solutions, such as 3D printing, or developing donations and take back schemes could facilitate access to spare parts for repairers.

Keywords: Right to repair, Circular Electronics Initiative, Circular Economy Action Plan, environment, IP

1 Introduction

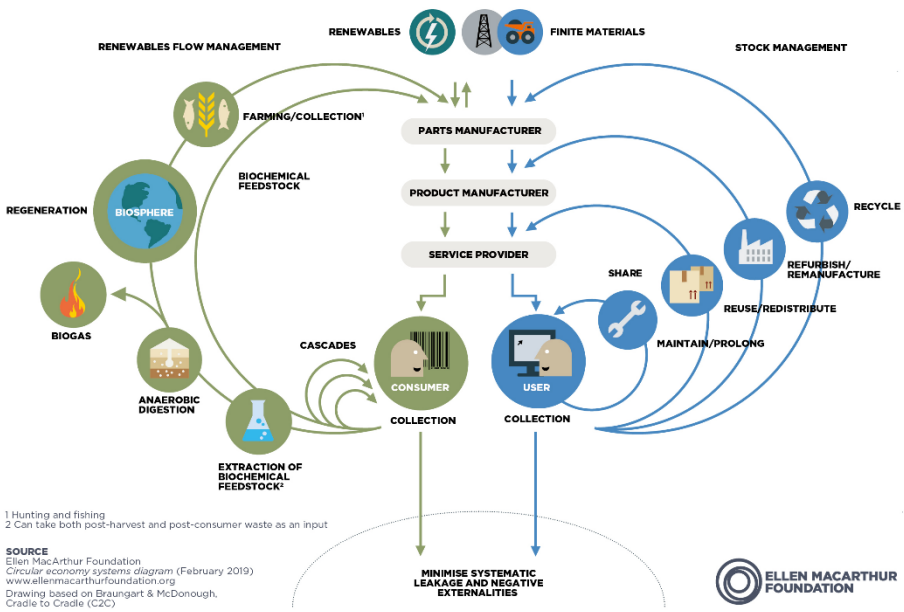
Achieving "prosperity in a world of finite resources"

Janez Potočnik, former European environment commissioner

By 2050, the world will be consuming as if there were three[1], with annual waste generation projected to increase by 70%[2]. Unlike natural ecosystems, which function in loops known as "closed systems" in the sense that they contribute to their own resilience by optimizing the recycling of non-renewable resources, the industrial economy is largely linear. The massive flows of raw materials and products deployed to meet our needs are the hidden currents of our lives, our shared metabolism as a society. In 2015, about two-thirds of the material we scratched from the planet slipped through our fingers. More than 67 billion tons of hard-won resources was lost, most of it scattered irretrievably. We only managed to capture and keep in the loop 9% of the total. This is the "circularity gap".

The circular economy is a collection of strategies — such as reducing, reusing, and recycling, renting rather than owning things — that together are meant to reshape the global economy, decoupling of material consumption from environmental impacts by keeping materials inside the loop to eliminate waste. It therefore aims to maintain and optimize the value of products and materials for as long as possible; waste and resource use are minimised, and resources are kept within the economy when a product has reached the end of its life, to be used again and again to create further value through more efficient production and use of goods and services, with the aim of increasing their resilience or sustainability of these resources. Circular Economy is seen as a business approach to sustainable development by focussing on waste valorisation and is based on the three pillars of sustainability: society, economy and the environment[3].

Figure 1. Circular economy systems diagram, Ellen MacArthur Foundation (2019)



The Circular Economy Action Plan[4] provides a future-oriented agenda aiming at accelerating the transformational change required by the European Green Deal[5]. This plan presents a set of interrelated initiatives to establish a strong and coherent product policy framework that will make sustainable products, services and business models the norm and transform consumption patterns so that no waste is produced in the first place.

[1] United Nations
[2] World Bank (2018)
[3] Möslinger (2019)
[4] COM (2020) 98 final
[5] COM (2019) 640 final

The Circular Electronics Initiative is part of the Circular Economy Action Plan specifically targeting electronics and ICT. It aims at addressing their shortcomings in durability, circular design, presence of hazardous and harmful substances, recycled content, reparability, access to spare parts, upgradability, e-waste prevention, collection, reuse and recycling; also calls for the integration of issues linked to early obsolescence including product obsolescence caused by software changes; calls for the harmonisation and improvement of recycling infrastructure for waste electrical and electronic equipment in the EU.

Electrical and electronic equipment continues to be one of the fastest growing waste streams in the EU, with current annual growth rates of 2%, while it is estimated that less than 40% of electronic waste is recycled in the EU[6]. Value is lost when fully or partially functional products are discarded because they are not reparable, the battery cannot be replaced, the software is no longer supported, or materials incorporated in devices are not recovered. The following report is the first of a set of reports on the right to repair for electronic devices, with a focus on mobile phones, tablets and laptops. It provides an overview of their environmental impacts throughout their value chain, defines the right to repair, lays out the regulatory framework and actions surrounding a potential Right to Repair in the EU and finally presents examples of implementation within and outside of the EU.

[6] Eurostat (2021)

2 An overview of environmental impacts of electronic devices

Understanding the environmental impacts of electronic products along their lifecycle and at the global level is key to assess the impact when moving towards a circular economy, and more specifically the impact of promoting the repair of electronic devices. This report mainly focuses on laptops[7], smartphones[8] and tablets[9].

The four key life-cycle stages assessed in more depth are:

- Mining and production of raw materials
- Processing, Assembly and Transport
- Use
- End-of-Life (Collection, Disposal, Recycling)

2.1 Methodology

A review of literature from research, NGOs and consultancies was conducted to provide an overview of the environmental impact of consumer electronic products. This included both life-cycle assessments (LCA) and studies looking more broadly at the global footprint of the ICT sector. LCA are commonly used to analyse the environmental impact of products, taking into account all the stages of its life cycle from cradle to grave. While the methodology for LCA is defined by ISO standards or similar standards across most studies, significant variations can be observed. They can result from differences between electronic devices in terms of materials, energy sources and processes used, but also from variations in assumptions and data. Regarding greenhouse gas emissions (GHG) assumed electricity mixes explain much of the variations in both production and use phases[10]. The considered lifetime of devices also has a significant impact. Comparing results is made harder by the lack of transparent studies. In addition to greenhouse gas emissions, a wide range of environmental impacts were considered, including toxic effects for humans and terrestrial or aquatic ecosystems, water and air pollution, depletion of abiotic resources (meaning natural elements and fossil fuels), eutrophication[11], acidification of soil and water, ozone depletion and photochemical ozone creation.

2.2 Mining and production of raw materials

The extraction of raw materials generally requires energy and water, generating pollution and waste, and often permanently or temporarily alters the surrounding habitat. The environmental impact depends on the type of material mined, the geographical location, the type of mining used as well as environmental standards applied.

2.2.1 Materials needed for electronic consumer goods

Electronic devices require many raw materials, many of them classified as being 'critical'. The European Commission identified 30 materials as critical raw materials in 2020. Their criticality is based on their importance for the economy and their risk of supply[12]. Critical raw materials often include conflict materials, meaning materials whose mining involves forced labor or finances conflicts. These typically include minerals such as tin, tungsten, tantalum and gold[13].

A 'simple' smart phone contains more than 60 materials. Its main composition is 25% silicon, 23% plastic, 20.5% iron, 14% aluminium, 7% copper, 6% lead, 2% zinc, 1% tin and nickel. In addition, they typically contain metals such as palladium, silver, gold, cobalt, tantalum, gallium and indium. Seven materials used for mobile phones are critical raw materials[14]. Given the fact that 87% of the population uses their smartphone for less than two years, and many of these precious resources end up in landfills, there is huge potential to act[15]. The situation is similar for tablets.

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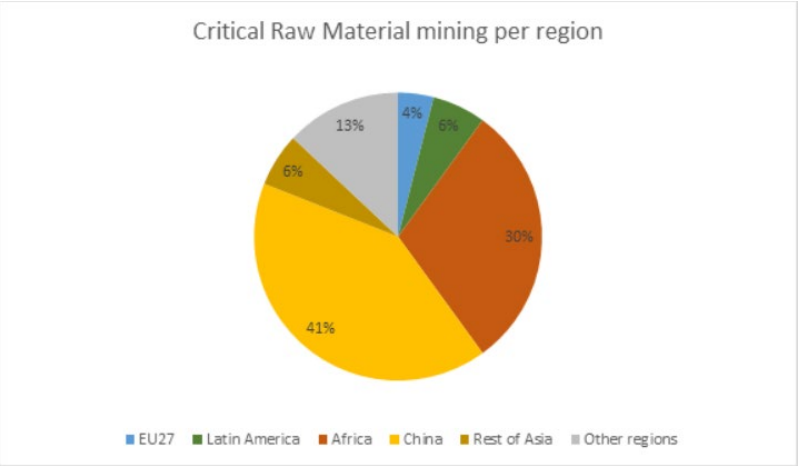
[7] Franze & Ciroth (2011)
[8] Suckling & Lee (2015); Clément et al. (2020); Ercan et al. (2016)
[9] Clément et al. (2020)
[10] Clément et al. (2020)
[11] Eutrophication refers to the enrichment of water with excess nutrients. This can lead to algae growth which consumes oxygen in the process and can lead to the water becoming anoxic and therefore toxic to other life in the water. For more information see: http://www.vliz.be/projects/iseca/en/science-for-all/what-is-eutrophication.html
[12] COM/2020/474 Final
[13] https://ec.europa.eu/trade/policy/in-focus/conflict-minerals-regulation/regulation-explained/
[14] Vol (2020)
[15] Vol (2020)

A typical laptop is made up of 50% aluminium and steel, 26% of ABS-PC (Acrylonitrile Butadiene Styrene – Polycarbonate) plastics, 9% epoxy (thermoset plastics that are used as adhesives), 12% metals (of which the 78% is copper, 18.5% Cobalt, 2.6% Tin, and 0.5% each neodymium and tantalum). Laptops contain as much as thirteen critical raw materials (tantalum, indium, palladium, platinum, gallium and eight rare earth materials)[16]. As these often occur in only small quantities, this poses additional challenges for later stage recycling[17].

2.2.2 Location of mines

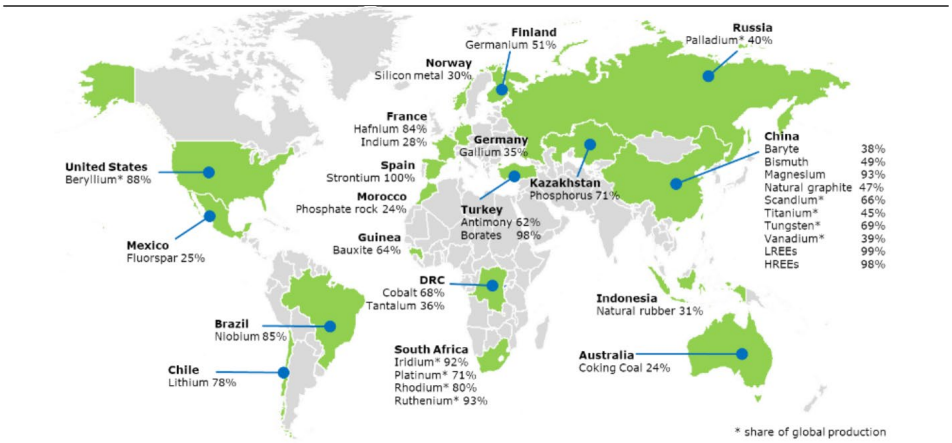
Material extraction for components of electrical equipment mostly takes place outside of Europe. Of critical raw materials for digital technologies, only 4% of the raw materials stem from the European Union while 41% are mined in China and 30% in Africa.

Figure 2. Share of critical raw materials mined per region (EC 2020)



Especially for critical raw materials that can be found in electronic consumer goods, the EU heavily relies on China, who is mining almost exclusively all light and heavy rare earth materials (such as neodymium that is needed for magnets or for instance, to create vibration in a cell phone), but also large quantities of tantalum and tin. The Democratic Republic of Congo as well as South Africa provide many additional raw materials that are critical for electronic equipment.

Figure 3. Biggest supplier countries of critical raw materials to the EU (EC 2020[18])



[16] For more details on raw materials in the individuals components, see European Commission, Joint Research Centre (2020)
[17] Circular Computing (2019)
[18] COM (2021) 350 final

Action is needed to avoid raw materials usage and associated impacts to increase as well as an increasing dependency on foreign countries. Potential alternatives include better usage of sustainable European mining capacities, exploiting urban mine potential and expanding the life-span of products through longer life-spans, reuse, repair and recycling[19].

2.2.3 European mines

Only one percent of non-ferrous metal extraction happens in Europe[20]. While most raw materials are mined outside of Europe, Europe has some of the mines with the highest environmental protection standards and lowest overall environmental impact. One example is the Kemi Mine in Outokumpu in Northern Finland mining chromite ore for the production of stainless steel[21]. Due to high environmental standards and cleaner energy mixes, Europe's metal production is 2.5 to 8 times less carbon intensive than, for instance, Chinese metal production in its current state[22].

2.2.4 Mining types and harms

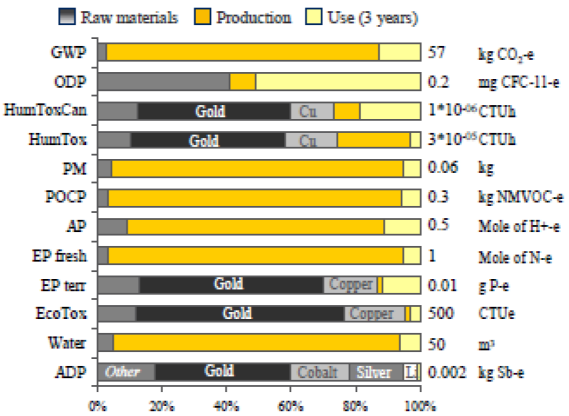
There are different ways of mining to extract raw materials. The typical way is open pit mining, usually requiring large amounts of ores to extract minerals and removing surface vegetation. Crushing unexposed rocks can lead to the exposure of radioactive elements, asbestos and metallic dust into the immediate environment and the remaining tails often contain radioactive or toxic substances. Another form of mining is underground mining with risk for toxic leaks into water and air, and especially mercury contamination of surrounding water bodies of not properly managed; land subsidence, topsoil removal, deforestation and erosion.

Alternatives are in-situ leaching (ISL), where the ore body is already dissolved underground and disturbances to the environment are lower and less water is needed for the mining process. However, the remaining acids possibly contain higher metal and radioactive concentrations that could leak into surrounding water bodies. Toxic fluids are equally a risk in heap leaching.

Operating a mine is still heavily dependent on fossil fuels. Additional impacts stem from high water usage and wastewater production unless water recycling systems are in place[23].

In terms of greenhouse gas emissions, the impact of raw materials extraction is relatively limited compared to other phases. For example, Ercan et al. assess that it represents 3.4% of a smartphone's life cycle GHG emissions.

Figure 4. Different types of lifecycle impacts for a smartphone (Ercan et al. 2016)



For impacts other than greenhouse gas emissions, the mining and processing phase of raw materials has the most significant negative impact throughout the product's life cycle, between 70-95% for human toxicity,

[19] Keating (2020)
[20] Wyns et al. (2019)
[21] https://www.outokumpu.com/en/sustainability
[22] Wyns et al. (2019)
[23] MIT (2016)

terrestrial eutrophication potential and ecotoxicity[24]. Despite of their comparatively small quantities, gold and copper contributed well over two-thirds of the measured impact in these categories.

Heavy metals (such as cadmium, mercury, lead and nickel) are currently essential in most electronic devices. Lead exposure causes brain damage in children and has already been banned from many consumer products. Mercury is toxic in very low doses and causes brain and kidney damage. It can be passed on through breast milk; just 1/70th of a teaspoon of mercury can contaminate 20 acres of a lake, making the fish unfit to eat. Cadmium accumulates in the human body and poisons the kidneys. [25,26].

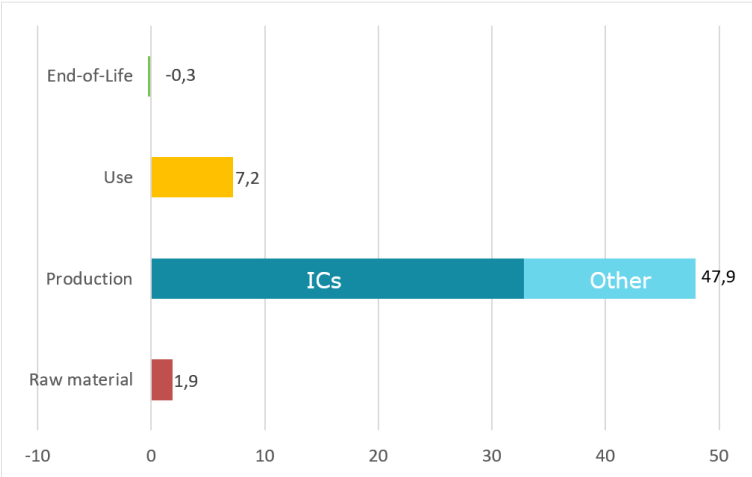
The negative impact on abiotic resource depletion stemmed almost exclusively from the mining and processing of raw materials with gold, cobalt and silver as the main materials causing this impact.

2.3 The production phase

The production phase is typically defined as the phase going from cradle (extraction or resources) to the factory gate (i.e. before the product is delivered to the consumer). The mining and extraction of raw materials is thus not always distinguished.

In terms of global warming impact, research clearly highlights the prevalence of the production phase in the life cycle impact of battery-powered electronic devices. An analysis of the existing literature shows that the production accounts for a relative share of 70 ± 12% (including raw materials) of GHG emissions for smartphones, and 68.4 ± 21.3% for tablets[27]. Ercan et al. find that production alone represents 84.5% of a Sony Z5 smartphone's footprint (see figure below). The proportion is similar for desktop computers (e.g. around 70% for the Lenovo ThinkPad used to write this paragraph). For always connected devices such as desktop computers the production phase represents a smaller, yet still important, share of the GHG emissions. For a 24-inch iMac, it is of 45%[28].

Figure 5. Global warming potential (in kg CO_2e/3 years) for a smartphone Sony Z5, including accessories but excluding network (Ercan et. Al. 2016)

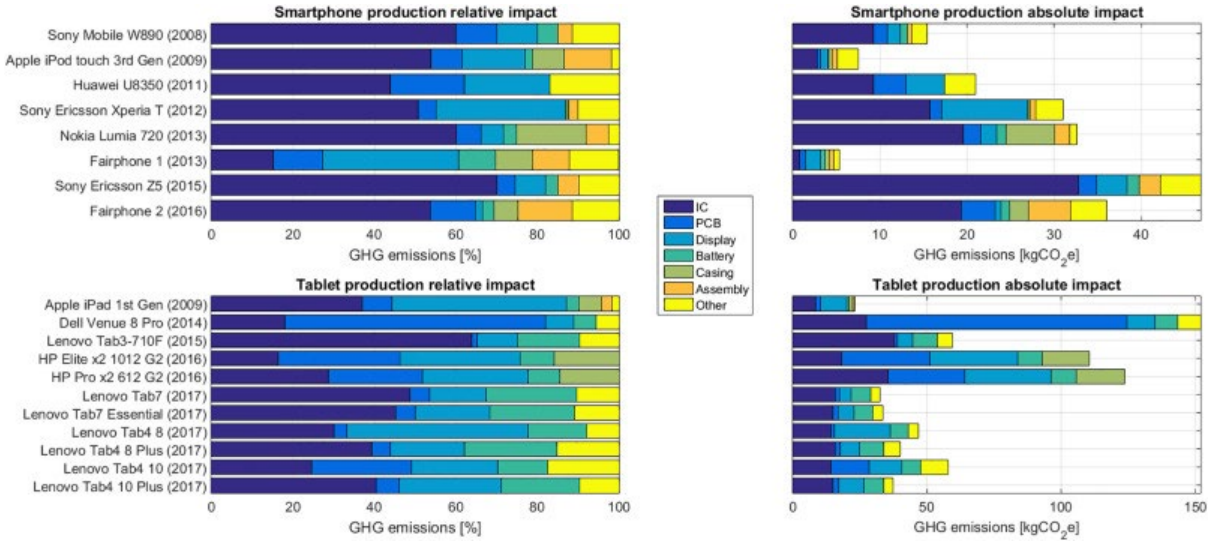


The carbon footprint of ICT devices results mainly from the high use of energy required to produce the different components. For smartphones and tablets, the integrated circuits (IC), the display (screen) and the printed circuit boards (PCBs) have the highest impact, followed by the casing and the battery[29]. Ercan et al., for example, found that out of the 48 kg CO2e resulting from the production of Sony Z5, 33 kg are associated with the production of the IC. Due to the high energy use during the production phase, the location of the production plants is crucial as the sources of energy used will determine the GHG emissions. A report by the Carbon Trust, UK Knowledge Transfer Network and Coventry University[30] estimated that remanufacturing

[24] Ercan et al. (2016)
[25] Electronics TakeBack Coalition
[26] European Chemicals Agency, https://chemicalsinourlife.echa.europa.eu/know-your-electronics
[27] Clément et al. (2020)
[28] Apple
[29] Clément et al. (2020)
[30] Carbon Trust et al. (2015)

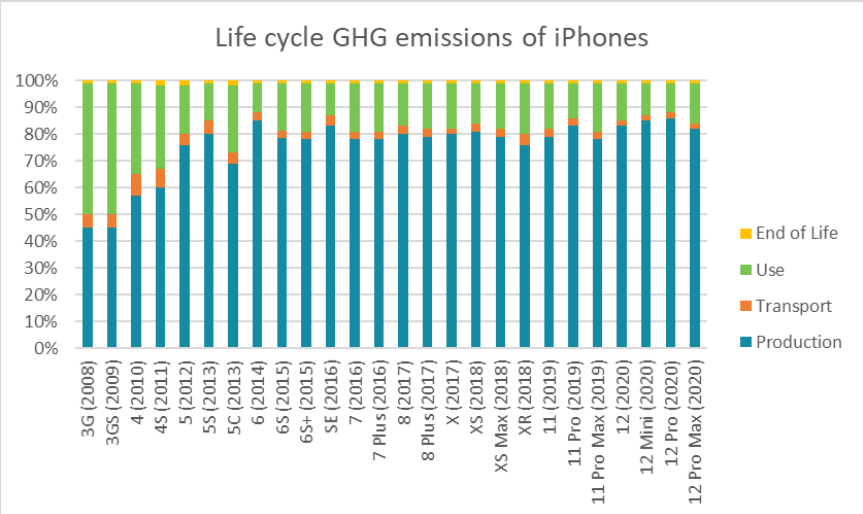
typically uses 85% less energy than manufacturing, and that on a global scale it could offset more than 800 000 tons of CO2 emissions per annum. This would be approximately equal to 170 000 cars less on the road per in a given year[31].

Figure 6. Subcomponent production GHG emissions impact for smartphones (Clément et al. 2020)



Due to improvements in the energy efficiency of devices during the use phase, and to constantly increasing hardware capability, a rising share of device life-cycle carbon emissions come from manufacturing[32]. To take the example of iPhones, the share of production in GHG emissions was 45% for the iPhone 3GS in 2009, and 83% for the iPhone 12, released in 2020[33].

Figure 7. Greenhouse gas emissions of iPhones at different lifecycle phases (Apple)



The impact of the transport phase is relatively small. For iPhones, it represented on average 3.5% of GHG emissions for the 2008-2019 period.

2.4 The use phase

For peripheral equipment, energy consumption is much lower in the use phase than during the production phase. According to the Shift Project, taking into account periods of conservation of 2, 4 and 5 years

[31] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator
[32] Gupta et al. (2021)
[33] https://www.apple.com/lae/environment/

respectively, for smartphones, laptop computers and connected televisions, the direct energy consumption for utilization represents 6% for smartphones, 11% for laptops and 33% for televisions. The GHG emissions at this stage are highly dependent on the energy mix in the location where the equipment is used, due to the important diversity in carbon intensities for energy production. The lifespan of products has a critical impact on estimating the impact of different phases, but even more so when assessing the total footprint of the ICT sector. The lifespan of smartphones is difficult to estimate. Several studies assume a 3 year lifespan, but there is a wide variance depending on type, usage and quality and the actual lifespan could be closer to 1.8 years[34].

While assessments of the GHG impact of the use phase typically focus on the energy necessary to run the device, the inclusion of the energy used indirectly through the traffic generated in the network by using the device changes the conclusion significantly, calling for caution when comparing studies. Ercan et al. 2016 find that, based on a representative use scenario, the total impact increases by 43 kg CO2e per year when taking into account the induced traffic, compared to a yearly device impact of 19kg excluding network usage.

Toxicity in particular is a concern for all life-cycle stages, but has a specific importance for the use phase given the direct daily and long-lasting interactions with the product. Flame retardants, which are used to prevent or slow down the progress of a fire, can migrate from electronic products into the dust in your house, or, for some new electronic devices, be released when they get hot. These substances remain in the natural environment for a long time. Lead Brominated flame retardants (BFRs) may seriously affect hormonal functions critical for normal development[35,36]. A study of dust on computers in workplaces and homes found BFRs in every sample taken. One group of BFRs, PBDEs, has been found in alarming rates in the breast milk of women in Sweden and the U.S.[37] Retailers are increasingly focusing on CoHC (*chemicals of high concern*) in articles, which aside from BFRs and heavy metals include different types of plastics.

2.5 The end-of-life phase

2.5.1 E-waste

E-waste is increasing rapidly. According to the Ellen MacArthur Foundation, 44.7 million tonnes of e-waste were generated globally in 2016. 435 000 tonnes were mobile phones[38]. Just 20% of e-waste is collected and recycled appropriately[39]. While this rate is generally higher in the EU and stood at around 49% in 2016, a large portion of waste does not receive proper recycling and care. Problems include scavenging (meaning the removal of valuable parts and inappropriate handling of the remaining waste), lack of recycling infrastructure, vast disparities between member states and exports outside of the Union to countries with poor waste management systems[40]. Annual solid waste production is set to increase by 70% by 2050 unless urgent actions are taken. Poorer populations involved in informal waste management are disproportionally affected as 90% of waste in developing countries is being mismanaged and 33% of solid waste openly dumped and burned[41]. E-waste also has a gender impact, as social norms in many cultures condition women to be more often in charge of waste management. Health risks in the health sector have been widely documented, including the consequences of heavy metals exposure from e-waste on women's general and maternal health[42].

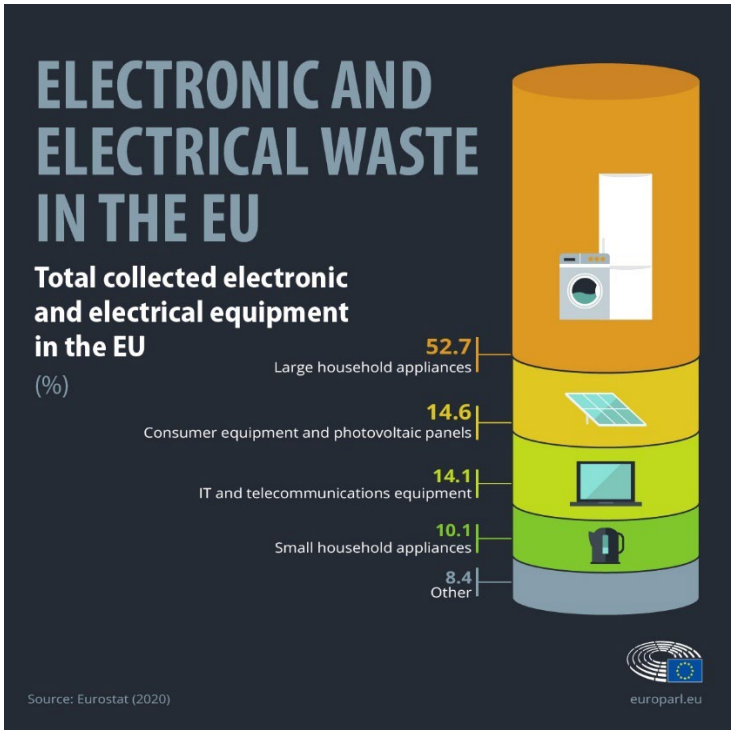
E-waste is considered a hazardous waste due to its toxic content, such as mercury, lead and brominated flame retardants. As e-waste is oftentimes shipped from Europe to developing countries with inadequate waste management systems, these wastes and up in landfill with harmful and toxic impact on the environment[43]. This includes the plastic components in electronic equipment[44].

[34] Belkhir et al. (2018)
[35] Electronics TakeBack Coalition
[36] European Chemicals Agency, https://chemicalsinourlife.echa.europa.eu/know-your-electronics
[37] Hines (2004)
[38] Ellen Mac Arthur Foundation (2018)
[39] Baldé et al. (2017)
[40] Ecos. (2019)
[41] World Bank (2018)
[42] Kim et al. (2020)
[43] Basel Convention (2011)
[44] Taylor (2020)

At the same time, e-waste contains many valuable materials, such as copper, nickel, gold, and rare earth materials, such as indium and palladium (amongst many more), which are valuable secondary raw materials[45].

The following infographic shows the production of e-waste in the European Union.

Figure 8. Total collected electronic and electrical equipment in the EU (European Parliament, Eurostat data[46])



What can be seen is that IT equipment amounts to about 14% of the electronic waste. However, large and small household appliances make up more than 60%. While having IT equipment as a starting point, these numbers should be kept in mind when aiming at addressing the issue of e-waste in the context of waste production and need for circularity.

2.5.2 Collection and recycling

While only 1% of metal ores are mined in Europe, 24% of secondary materials are treated and refined there, giving Europe a large competitive advantage and high expertise in this sector[47]. However, the recycling rate still needs to be increased. Currently, less than 40% of e-waste is recycled in the EU, and the European Court of Auditors warned that only Croatia and Bulgaria are on track for achieving the new and more ambitious targets. Illegal waste streams abroad or to dumping sites were highlighted as an additional problem in the Auditor's report.[48,49] These informal recycling processes have a "major impact on human toxicity"[50].

To reach a higher recycling rate, several other hurdles need to be overcome.

The trend for miniaturization in electronic equipment, wherever smaller quantities of raw materials and components are built into devices increases the energy consumption during the recycling process, "since the energy needed to separate the metals increases as a function of the complexity of the assembly"[51].

Secondly, plastics in electronic equipments provide an additional recycling challenge. They often contain brominated flame retardants and make up up to 25% of the overall e-waste stream. When recycled these

[45] Basel Convention (2011)
[46] https://www.europarl.europa.eu/resources/library/images/20201210PHT93524/20201210PHT93524_original.jpg
[47] Wyns et al. (2019)
[48] Taylor (2021)
[49] European Court of Auditors (2021)
[50] Teehan et al. (2012)
[51] The Shift Project (2019)

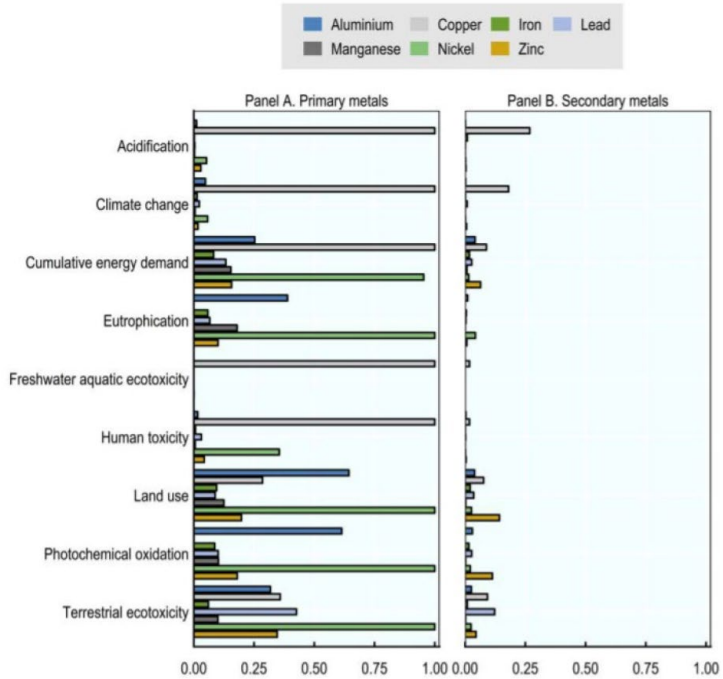
flame retardants remain in the recycling stream. Higher recycling rates and safer alternatives are needed to allow for redesigning the sector for a circular economy and making prices of recycled materials more competitive with virgin materials[52].

Thirdly, many electronic products that are no longer used remain in households without being returned for recycling. "Used products are often kept in households without providing any additional service, which is also referred to as hibernation[53]. With an abundance of materials in use or in place in society, the concept of 'urban mines' becomes more and more relevant. Using existing materials, repairing and refurbishing them and eventually developing more advanced recycling technologies is seen as a way to reduce further the environmental footprint of electronic equipment[54].

2.5.3 Secondary materials use

An environmental impact assessment on seven key metals in electronic equipment (namely, iron, aluminium, copper, zinc, lead, nickel and manganese) found that the negative environmental impacts of primary metals (stemming from extraction and processing) were up to ten times higher than of secondary metals (meaning recycled metals)[55]. In addition to the main materials studied, plastic production and disposal is responsible for considerable greenhouse case emissions and environmental impacts, especially on marine ecosystems[56].

Figure 9. Environmental impacts of different materials (OECD[57])



The OECD's Global Material Outlook for 2060 highlights the difference between the environmental impact of primary and secondary metal used for electronic consumer goods. In addition, for individual metals used it showed that copper and nickel caused the highest environmental impacts per kilogram while iron had the highest absolute environmental impacts as it was used in larger volumes.

Secondary material that is recycled rather than freshly mined can have a tenfold smaller environmental impact across all measured impact categories. The much lower energy demand for production is also pointed

[52] European Court of Auditors (2021)
[53] Oswald & Reller (2011)
[54] Tercero Espinoza et al. (2020)
[55] The impacts considered were within the categories of acidification, climate change, cumulative energy demand, eutrophication, human toxicity, land use, photochemical oxidation, as well as in aquatic and terrestrial ecotoxicity.
[56] OECD (2019)
[57] *Op. cit.*

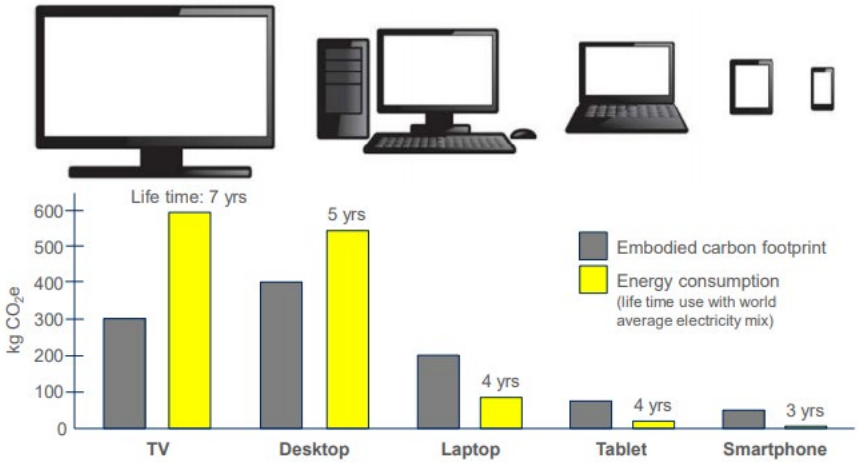
out by industry, whilst providing the same quality of the material as for virgin materials[58]. However, this requires to build in recyclability already at the design step of the product and emphasize the importance of the choice of material made for the electronic products designed.

2.6 Overall impact

Looking at the whole lifecycle, electronic devices have a significant impact in terms of carbon footprint. A smartphone contributes about 55 ± 12 $kgCO_2e$. CO_2-eq., assuming a lifespan of three years[59], a tablet typically more, for example 113 kg for an iPad Pro[60,61], but with more important variations depending on models, and a laptop around 200kg CO_2-eq., assuming 6 years of usage[62]. Larger devices tend to have a higher footprint, as they require more materials, components and more energy to power large displays (see figure 10).

Figure 10. Estimated embodied and use carbon footprints for key user devices (Malmondin & Lunder 2018).

Note: Desktop PCs include an LCD monitor and standard peripherals, but laptops do not.



Despite of gains in energy efficiency, increased complexity and capacity have led to higher lifecycle footprints over time[63]. For example, the carbon footprint of iPhones was 17% higher on average (taking into account the main models) during the 2017-2020 period than during the 2008-2017. The launch of high-end smartphones (e.g. iPhone 6 Plus, iPhone 12 Pro) reinforces this trend.

While the impact associated with ICT devices may appear small compared to other activities, it is important to look at the global trends to understand the real impact of ICT devices. The number of smartphones in use grew from 485 million in 2010 to 3.6 billion in 2020 and could reach 8.7 billion in 2040[64]. Smartphone's GHG emissions have increased by 730% in 10 years, from about 17 $MtCO_2$-e in 2010 to 125 $MtCO_2$-e in 2020. In 2020, they were expected to represent 11% of the total footprint of the ICT sector, compared to 4% in 2010[65]. While estimates vary (39% in 2020[66], 54% in 2015[67]) research clearly shows that user devices represent a major share of the ICT sector's carbon footprint. For Malmondin and Lunden, out of the 730 Mt (1.4% of global emissions) emitted by the ICT sector in 2015, 395 Mt came from such devices. In addition, TVs, TV networks and consumer electronics emitted 420Mt. By replacing or reducing the use of older, energy inefficient hardware solutions, and by making a wide variety of services that were offered by separate

[58] Taylor (2020)
[59] For the impact on climate, the most common indicator is the GWP100, which consists of a quantity of GHG (greenhouse gas) emissions in $kgCO_2$-eq. (kilograms carbon dioxide equivalent).
[60] Clément et al. (2020)
[61] iPad Pro (11-inch) Product Environmental Report (apple.com)
[62] Hischier et al. (2014)
[63] The Shift Project (2019)
[64] Belkhir et al. (2018)
[65] *Op. cit.*
[66] *Op. cit.*
[67] Malmondin et Lunden (2018)

hardware (cameras, alarm clocks, calculators, etc.) available via a single platform, smartphones may have contributed to reducing the global footprint of electronic devices.

However, it is possible that the Covid-19 crisis resulted in a shift in this trend, with recent increases in computer sales[68].

Figure 11. Relative contributions of ICT categories in the total GHG emissions of the sector (Belkhir et al. 2018)

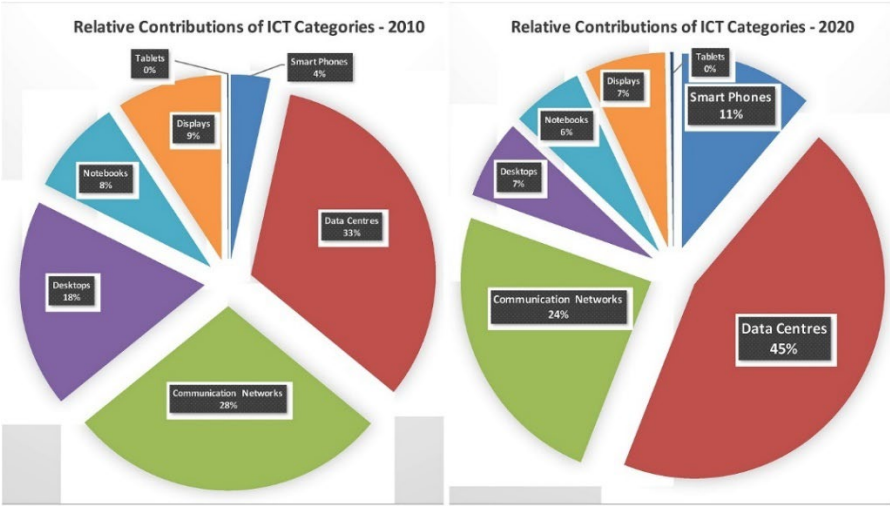
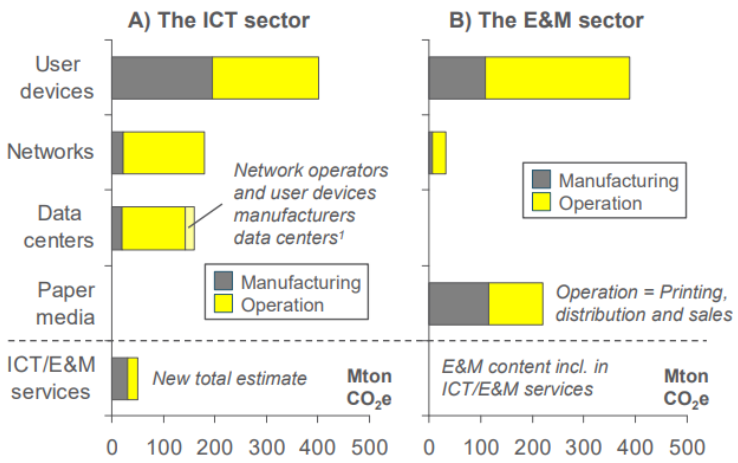


Figure 12. Total carbon footprints for the ICT and entertainment and media sectors in 2015 (Malmondin & Lunden 2018.)



[68] Müller (2021)

3 Overview of the right to repair

The worrying trends of worsening environmental impact of electronics call for a holistic policy response. E-waste continues to be one of the fastest growing waste streams in the EU, growing about 2% per year[69]. Regulatory measures on raw materials, restrictions of hazardous substances or eco-design requirements can play a role in incentivizing companies to build more eco-friendly and durable devices. However, due to changes in technology and types of device in demand, the major part of the environmental impact of electronics results from the extraction of raw materials and production processes. The negative impact of producing new products are far superior to the benefits of replacing smartphones, tablets or laptops with greener, more energy-efficient models. In particular, smartphones have the fastest-growing demand and shortest lifespan, placing it at the top of the most impactful electronic devices. Research has shown that extending the lifespan of smartphones by just one year would save the equivalent of taking two million cars off the roads annually in the EU[70].

3.1 Definition of the right to repair for electronics

Incentivizing the repair of functioning electronics could help extending their lifespan. A recent Eurobarometer survey showed two in three Europeans would like to keep using their current digital devices for longer, provided performance was not significantly affected. However, the ever-increasing complexity of electronic devices – ever more light-weight, compact and requiring less material – often translates into increasing repairing and recycling difficulties. Consumers' capacity to repair their own devices has decreased over the years. For example, according to iFixit[71], a smartphone Samsung Galaxy S4 from 2013 had a reparability index of 8/10, while the Samsung Galaxy S20 Ultra from 2020 scores a low 3/10. This means consumers rely on either the manufacturer or a professional repairer to fix or maintain their products. Manufacturers enjoy a *de facto* dominant position in their products' repair markets and some have been accused of restricting access to spare parts or limiting them to authorized re-sellers only. Regular claims of 'planned obsolescence' accuse companies of intentionally shortening product life through software updates and design strategies to force consumers into buying new products. Apple and Tesla both have been accused of reducing battery life through software updates in 2017 and 2020 respectively.

3.1.1 Principle and remit of a right to repair

These concerns have led to calls for government to introduce a 'right to repair', a consumer-empowering and positive right to ensure consumers are able to have their electronics repaired easily and at a reasonable and affordable cost. The official definition of the U.S. Repair Association is that the "*right to repair [...] is the consumer's right to choose who, what, where, why, when, how and for how much their equipment is to be repaired*".

Nevertheless, there is no universal definition of a right to repair. In an enquiry conducted by the Australian Government Productivity Commission[72], participants most commonly associated a right to repair with:

- independent repairers and consumers having access to the necessary parts, information and equipment needed to repair products, including access to embedded software in products
- consumers having the choice of repairer, with price competition in the repair market
- consumers being able to buy products that are repairable and durable
- repair/reuse of products to reduce e waste and encourage the growth of the circular economy

The remit of the right to repair is thus subject to debate and needs to balance the competing interests of all involved stakeholders. A right to repair can exist either in a closed access system, where the consumer is restricted to the repair services provided by the manufacturer or authorized repairers – a situation closer to the current reality. Or, a right to repair can evolve in an open access system, which implies full access to spare parts, tools, repair manuals and digital permission to repair. Policy options for a right to repair differ based on whether they encourage one or the other approach. Some argue an open access system is the only form or right to repair that is consumer-empowering and can yield the expected benefits. Others argue for a more complex system, moving towards open access but with some safeguards on a sectoral or product category-basis. A cost-benefit analysis could help identify the sectors or product categories where a full open access

[69] Circular Economy Action Plan, European Commission, 2020, here
[70] European Environmental Bureau, 2019 here
[71] https://www.ifixit.com/smartphone-repairability , 26.02.2022
[72] Productivity Commission (2021)

right to repair would not be desirable. For instance, a right to repair for medical devices should be closely supervised for health and safety considerations, while the right to software updates should depend on cybersecurity concerns.

3.1.2 Applications of a right to repair for electronics

The absence of a universal definition creates difficulties on a political and policy level, which is partly to blame for the difficult operationalisation of a 'positive right to repair'. First, choosing the remit of the right is a political decision that will have to handle competing interests from various constituencies: consumers, manufacturers, suppliers, repairers. Second, there is no single policy that can enable a right to repair. Policy-makers need to mainstream it through a variety of interconnected policy areas: consumer and competition law, intellectual property protections, product design and labelling standards as well as environmental and resource management. Implementing or amending policies in any of these areas requires careful consideration to avoid negative externalities and, there too, balancing the interests of the different stakeholders. For instance, policy proposals to enable a right to repair could include: legal obligations on manufacturers to provide access to repair inputs; strengthening of the consumer guarantees under Consumer Law; changes to intellectual property protections to facilitate sharing of repair information and access to embedded software; introduction of unfair conduct provisions to address behaviors of manufacturers; and use of minimum product standards and labelling[73].

To ensure the effectiveness of a right to repair, three considerations of legal, economic and societal elements need to be taken into account. There needs to be (1) full access to repair, meaning the fundamental legal and non-legal barriers preventing accessible repair are removed; (2) competitive repair, implying that the total price of repair and other competitive factors do not deter consumers from choosing repair as an economic and convenient option; and finally (3) mainstream repair, reached by shifting the consumer preferences and attitudes towards repairing their devices[74]. Operationalization of a right to repair also relies on consumer awareness and effective enforcement by authorities.

In the case of electronics, an added layer of complexity relates to their reliance on software. The rise of tech-enabled products means that much of the information required to diagnose or fix a fault is digital, embedded into the product itself and held being 'digital locks', requiring passwords or special tools to bypass. Relatedly, the development of an operating system or a software can decide to end support of older generations of devices, despite them remaining fully functional. The right to repair electronic devices therefore is often coupled with a right to update obsolete software.

Approaches to the implementation of a right to repair differ from countries to countries. In the United States, much of the debate has focused on consumer and competition issues, particularly access to necessary spare parts, tools and information, and the tension this can create with intellectual property rights. The term 'right to repair' appears to have originated from legislation in Massachusetts requiring motor vehicle manufacturers to provide access to diagnostic and repair information.

In the EU, a right to repair is more commonly associated with product design and resource management, and is generally pursued through EU environmental regulations. In addition, diverging national obligations, ranging from information requirements on technical operations performed on refurbished electronic devices, on the duration of software compatibility (such as in France), to reporting obligations on handling unsold durable goods (such as in Germany), give clear indications of a trend to take regulatory action by setting ecodesign requirements on goods. As a consequence, without EU action, there will inevitably be an increase in national obligations and increased market fragmentation.

3.2 Regulatory framework and policy landscape of a right to repair in Europe

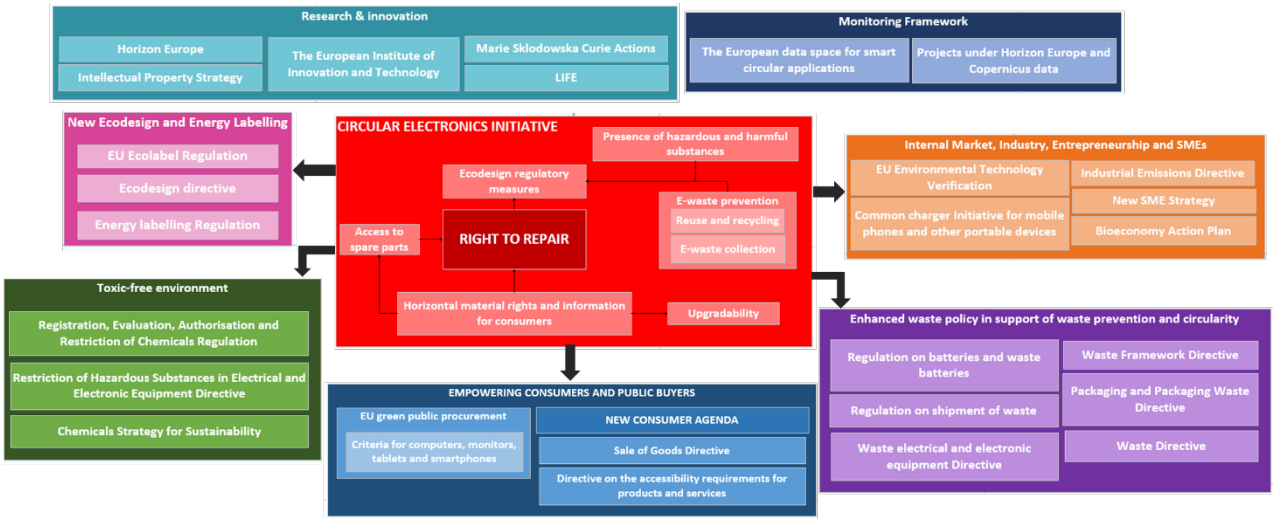
The EU Green Deal sets tackling climate change and environmental degradation as a key priority of the European Commission. The Circular Economy Action Plan (CEAP) will help reach the Green Deal's objectives of lower resource consumption and reduced environmental impact. The CEAP contains an initiative for sustainable products, with an additional initiative on Circular Electronics. The right to repair is a part of the Circular Electronics Initiative.[75] The right to repair links to several existing legislatives documents in the areas of waste management, pollution and emissions control, standards, the SME strategy, eco-design, consumer

[73] Productivity Commission (2021)
[74] Svensson et al (2018)
[75] https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

rights and many more. Within the wider Sustainable Products Initiaitve which brings all products produced or sold in the EU in line with technical standards for sustainability. The sustainable product legislative initiative and other complementary approaches will improve coherence with existing instruments regulating products in various phases of their life cycle.

Figure 13 depicts the EU regulatory framework and policy landscape around the Right to Repair.

Figure 13. EU Policy landscape around the Right to Repair



The Right to Repair falls into a wider landscape of regulation on sustainability of products and production, waste legislation, consumer rights and protection legislation, environmental legislation relating to toxicity as well as research, innovation, commercialization and IP rights. For instance, the EU's sustainable product policy, ecodesign legislation and energy labelling are effective tools for improving the energy efficiency and sustainability of products. They help eliminate the least performing products from the market and support industrial competitiveness and innovation by promoting the better environmental performance of products throughout the internal market. A proposal for an updated sustainable products initiative was adopted as part of a circular economy package on 30 March 2022.

The Sustainable Products Initiative includes a new Ecodesign for Sustainable Products Regulation, which will cover a wider range of requirements and products : product durability, reusability, upgradability and reparability; presence of substances that inhibit circularity; energy and resource efficiency; recycled content; remanufacturing and recycling; carbon and environmental footprints; and information requirements, including a Digital Product Passport. New rules build on the existing Ecodesign Directive, which sets ecodesign requirements at EU level for energy-related products. They propose to cover almost all products on the EU market and therefore also apply to electronic appliances. Article 1 lays down the product aspects to which the eco-design requirements relate, including upgradability, reparability, and possibility of maintenance and refurbishment. Article 5 lays the grounds for ecodesign requirements. Based on the Ecodesign Directive, the Commission shall establish ecodesign requirements to improve the product aspects, including upgradability, reparability, and possibility of maintenance and refurbishment. Performance requirements will be used to ensure the removal of the worst performing products from the market where this is necessary to contribute to the environmental sustainability objectives of the Regulation. They are to relate to a selected product parameter relevant to the targeted product aspect for which potential for improving environmental sustainability has been identified. An example of a non-quantitative requirement is the prohibition of a specific technical solution that is detrimental to product reparability.

Recent studies show that up to 80% of EU consumers claim to have difficulty in finding information on how easy it is to repair a product[76]. The sustainable products initiative therefore also includes a proposal for a Directive on empowering consumers for the green transition. Amongst other things, the proposal aims at providing information on the reparability of products, through a reparability score or other relevant repair information, where available, for all types of goods. Indeed, the current Consumer Rights Directive does not

[76] European Commission, *Behavioural Study on Consumers' engagement in the circular economy*, 2018, p. 81.

contain specific requirements to provide information to consumers on the reparability of goods. Rather, it requires only information on 'after sale services' to be provided on a 'where applicable' basis.

Measures considered include:

- Amending Directive 2005/29/EC to prohibit presenting products as allowing repair when such repair is not possible, as well as omitting to inform consumers that it is not possible to repair goods in accordance with legal requirements.
- Amending Directive 2005/29/EC to prohibit omitting to inform the consumer that the good is designed to limit its functionality when using consumables, spare parts or accessories that are not provided by the original producer.
- Traders to provide, before the conclusion of the contract, for all types of goods, where applicable, the reparability score of the good as provided by the producer in accordance with Union law, to allow consumers to make an informed transactional decision and choose goods that are easier to repair.
- Ensuring information such as on the availability of spare parts and a repair manual, should no reparability score be available at Union level

To this end, new 'Digital Product Passports' providing information about products' environmental sustainability, will empower consumers and businesses to make informed choices when purchasing products, facilitate repairs and recycling and improve transparency about products' lifecycle impacts on the environment. The passports also help public authorities to better perform checks and controls.

In addition, as part of the implementation of the EU Circular Economy Action Plan, the European Commission has carried out a study[77] for the analysis and development of a possible scoring system to inform about the ability to repair and upgrade products.

To sum up, for an effective Right to Repair, adaptations of a wide set of legislation are in process and are needed in order to allow for repairs and refurbishment of products.

3.3 International and European examples of right to repair legislation

Until recently, regulatory measures to encourage repair directly or indirectly remained relatively uncommon[78]. In the past years, a number of initiatives have been taking place, mostly at state level for the US and the Member State level in the EU[79]. While this trend shows that promoting repair is gaining traction, it is also leading to growing differences between pioneers and those lagging behind. In most cases, repair-related measures do not target electronics specifically.

3.3.1 Availability of spare parts, tools, and repair information

Massachusetts became in 2013 the first U.S. State to enact a law[80] requiring car manufacturers to make available repair tools and information to independent repair businesses. In response to this law, automobile manufacturers concluded a Memorandum of understanding with independent car repairers[81] to provide the same conditions across the U.S. Encouraged by a strong repair movement, initiatives to extend this obligation to other sectors are blossoming in the U.S. 27 States are considering some form of right to repair bills that would require original equipment manufacturers to provide to independent repairers and consumers, "for purposes of diagnosis, maintenance, or repair", "documentation, parts, and tools, inclusive of any updates to information or embedded software", as well as information to allow security protections to be reset[82]. Most of these bills apply to digital electronic equipment in general, but some target more specifically medical

[77] European Commission, Joint Research Centre, Sanfelix, J., Cordella, M., Alfieri, F., Analysis and development of a scoring system for repair and upgrade of products : final report, Publications Office, 2019, https://data.europa.eu/doi/10.2760/725068

[78] ADEME (2018)

[79] Svensson et al. (2018)

[80] Commonwealth of Massachusetts (2013)

[81] Memorandum of Understanding, date 15 January 2014, by and among Automotive Aftermarket Industry Association, *Coalition for Auto Repair Equality, Alliance of Automobile Manufacturers and Association of Global Automakers*.

[82] The Repair Association (2021)

equipment or home appliances[83]. In June 2021, the New York State Senate was the first to pass such a bill[84], and a national right-to-repair legislation was filed with Congress[85].

In South Korea, spare parts must be available for 7 to 9 years, depending on the products, but this obligation is not enforced[86]. In the EU, some Member States have introduced specific measures regarding the availability of spare parts. Since 2014, France requires sellers to indicate to consumers the period during which the manufacturer or importer commit to provide the spare parts needed for repair of the purchased product, and, during that period, to provide within 2 months the spare parts upon request from any seller or repairer. It is however not mandatory to inform consumers whenever the parts are unavailable. In Slovenia, maintenance and spare parts need to be available for at least 3 years after expiry of guarantee. In Portugal, consumers have a right to after-sales assistance, which includes the provision of spare part, for the average expected lifespan of products supplied.

3.3.2 Legal guarantees

Regarding legal guarantees, some European countries have adopted rules going beyond the minimum harmonisation requirements established in the Consumer Sales and Guarantees Directive[87], and the recently adopted replacement[88], which can contribute to encouraging repair[89]. Several countries have introduced longer guarantee of conformity periods than the minimum 2-year period. It is of 3 years in Sweden. In Finland, it is tied to expected product lifespan. In the Netherlands, there is no time limit for claiming application of the legal guarantee: the application takes into account the expected lifespan of the good, based on guidelines based on the type of product and its quality. In Norway and Iceland, the legal guarantee of conformity is of 5 years for goods meant to last longer than 2 years. In Ireland, the UK and Scotland the limitations for the consumer to make claims of non-conformity is 6 years (5 in Scotland), but such claims need to be assessed on their individual merits. 10 Member States decided that during repair or replacement the 2-year duration of the guarantee of conformity is suspended and resumes as soon as the consumer receives the replaced or repaired good. In Austria, Croatia, Greece and Iceland, a new 2-year period starts when the product is repaired. Some countries have also adopted longer periods for the reversal of burden of proof, during which the seller is automatically deemed liable for lack of conformity, unless it can produce proof that the item was not defective when delivered. While the minimum period is of 1 year under the 2019 Directive, France and Portugal have 2 years period. The possibility for the consumer to choose between repair and replacement in case of non-conformity, unless the chosen remedy is impossible or disproportionately costly, introduced by the 2019 Directive, had already been adopted in France.

3.3.3 Design requirements

Another way to promote repair is to adopt design requirements facilitating reparability, as was done in the EU for certain categories of products. In the State of Washington, the proposed fair repair bill would expressly prohibit designing or manufacturing digital electronic products in such a way as to prevent reasonable diagnostic or repair functions by and independent repair provider, for example by permanently affixing a battery in a manner that makes it difficult or impossible to remove.

3.3.4 Financial incentives

Considering that cost can be a key barrier for repair for the customer, financial incentives are one of the solutions to encourage this practice. Some governments at national or local level subsidise repair of devices. The City of Graz, for example offers subventions for the repair of electric and electronic devices, reimbursing to households up to 50% of total repair costs, with a maximum of €100 per year. Other countries do not subsidise repair specifically, but include it in broader schemes. For instance, the Belgian *écochèques*, a means of payment for ecological purchases that employers can grant to their employees without taxes, can cover repair, including of electronic device. However they can also be used to purchase energy-efficient new appliance and are only used for repair in 5% of cases[90].

[83] U.S. PIRG (2021b)
[84] Purdy (2021)
[85] Gault (2021c)
[86] ADEME (2018)
[87] Directive (EC) 1999/44
[88] Directive (EU) 2019/771
[89] ECC-Net (2019)
[90] ADEME (2018)

In France, the cost associated to the collection, treatment and recycling of certain products under the extended producer responsibility principle is called the *éco-contribution*. This additional cost, for products like electronic devices, needs to be distinguished and visible by the consumer. This eco-contribution can be modulated for certain products based on, among others, reparability criteria. This includes, for laptops, upgrades of the product with common tools, and for tablets and smartphones the availability of essential software updates. However, considering the low amount of this contribution[91], it is unlikely to have an incentive effect.

3.3.5 Copyright law exemptions

In the US, copyright law can in some cases be an obstacle to the repair of products[92]. Section 1201 of the Digital Millennium Copyright Act makes it illegal to break technological locks over copyrighted content. While it aims to avoid piracy and illegal copies, it can also block repair. The Copyright Office has granted exemptions, notably for unlocking phones, tablets, mobile connectivity devices and wearables. These exemptions have to be renewed every three years, and this process has been criticized as burdensome and uncertain.

3.3.6 Information to consumers

A number of repair-related policies focus on providing information to consumers. One of the most ambitious is France's reparability index, introduced in January 2021. The index consists of a grade from 1 to 10 based on 5 main criteria: documentation, disassembly, availability of spare parts, price of spare parts, products specific aspects. Each criterion is assessed using a large range of parameters. For smartphones, laptops and TVs, product-specific criteria include software aspects. From January 2022, displaying the score will be mandatory for washing machines with door glass, smartphones, laptops, TVs and electric lawnmower. On request, manufacturers must provide a detailed reporting sheet showing the score for each sub-criteria. There are however no details on strong and weak points. The note is computed by manufacturers, and can be controlled ex-post by the market surveillance authority.

Table 1. Example of a reporting sheet for Fairphone 3+

Criteria	Sub-criteria	Score of subcriterion /10	Weighting factor of subcriterion	Score of criterion /20	Total criteria scores /100
CRITERION 1 : DOCUMENTATION	1.1 Availability of the technical documentation and other documentation related to user and maintenance instructions	8,5	2	16,9	87,3
CRITERION 2 : DISASSEMBLY, ACCESSIBILITY, TOOLS, FASTENERS	2.1 Ease of disassembly parts from List 2*	10,0	1	20,0	
	2.2 Necessary tools (List 2)	10,0	0,5		
	2.3 Fasteners characteristics parts from List 1** and List 2	10,0	0,5		
CRITERION 3 : AVAILABILITY OF SPARE PARTS	3.1 Availability over time parts from List 2	7,9	1	14,4	
	3.2 Availability over time parts from List 1	6,4	0,5		
	3.3 Delivery time parts from List 2	6,7	0,3		
	3.4 Delivery time parts from List 1	6,7	0,2		
CRITERION 4 : PRICE OF SPARE PARTS	4. Ratio between price of parts from list 2 to the price of the product	8,0	2	16,0	
CRITERION 5 : SPECIFIC CRITERION	5.1 Information about type of updates	10,0	1	20,0	
	5.2 Free remote assistance	10,0	0,5		
	5.3 Possibility to reset softwares	10,0	0,5		
				Reparability index on 10	**8,7**

** list 2: list of a maximum of 3 to 5 spare parts (depending on the category of equipment concerned) whose broken or malfunctioning parts are the most frequent;*
*** list 1: list of a maximum of 10 other spare parts (depending on the category of equipment concerned) whose good condition is necessary for the operation of the equipment.*

3.3.7 Voluntary labels

The European Ecolabel is not the only one to provide information on reparability to consumers. EPEAT, the leading global ecolabel for electronic equipment, takes into account some reparability and upgradability criteria, such as spare part availability, disassembly with simple tools, provision of lists of tools and manuals, information on repair services, etc. This label has limitations: important criteria, like removability of the battery without tools, are only optional and the way criteria are written and interpreted allow most OEMs to

[91] €0.02 for smartphones, €0.25 for tablets and up to 0.42 for laptops.
[92] Issues related to copyright will be further analysed in the report focusing on barriers.

meet them. In Austria, there is a specific label for repair[93] applying to electrical and electronic appliance. A label for reparability is also under consideration for Benelux countries, with a study on the topic[94]. Some national or regional labels include repair criteria, such as the Blue Angel which, for computers, takes into consideration spare parts availability and could further develop reparability requirements in the future[95]. There also are labels to certify the quality of repairers, notably in the Netherlands and in France.

3.3.8 Green Public Procurement

Green Public Procurement, by taking into account environmental criteria, such as reparability, in public procurement can create an increased and consistent demand for more sustainable products. In the US, Federal agencies are required to purchase 95% of EPEAT-listed electronic products. On 14 June, seven countries signed the "international Circular and Fair ICT Pact"[96], an initiative co-led by the Netherland and Belgium aiming at creating a network of procurers contributing to a large collective demand for circular and fair laptops and smartphones. Among its core objectives is boosting the repair of ICT devices.

3.3.9 Communication and awareness raising

Tools like the Austrian website Raparaturführer help consumers identify repairers for the devices. Communication and awareness raising actions, for example the Repair Day in France, a fund to support initiatives related to repair and reuse in the UK, or the creation of repair hubs in Scotland or Sweden are also means to encourage repair.

Table 2. Recapitulative table: Examples of initiatives supporting the repair of electronic products

Type of measure	Measure	Examples
Access to repair parts, tools and information	Obligation to provide spare parts/information/tools for repair	Massachusetts (for cars), 27 US States (proposed), South Korea (not enforced), Portugal, Slovenia
	Information on availability of spare parts	France
Legal guarantee requirement beyond the EU Directive's provisions	Longer legal guarantee of conformity	Finland, Iceland, Norway, Netherlands, Ireland, Sweden, UK
	Extension of the reversal of burden of proof period	Portugal, France
	Suspension of the duration of the legal guarantee during repair or replacement	Belgium, Bulgaria, Ireland, Italy, Lithuania, Luxembourg, Malta, Netherlands, Norway and Romania
	Reset of the duration of the legal guarantee after repair	Austria, Croatia, Greece and Iceland
	Possibility to express preference for repair	France
Design requirements	Design requirements for reparability	State of Washington (proposed)
Financial incentives	Subsidies for repair of electronics	Cities of Graz, Vienna, Belgium
	Repair criteria impacting financial contribution to waste management	France
Copyright law	Specific exemptions for repair purposes	US

[93] ONR 192102
[94] Bracquené et al. (2018)
[95] DE-UZ 078-201701
[96] Circular and Fair ICT Pact (2021)

Information on reparability	Mandatory reparability index	France
	Voluntary labels on repair	EPEAT, Austria, Germany, Nordic countries, Belgium (second hand)
	Labels on repairer quality	France, Netherlands
Procurement	Repair criteria in public procurement	International Circular and Fair ICT Pact, US
Communication actions	Web platforms for consumers	Austria, France, Germany, Netherlands, Sweden, US (repair tutorials)
	Awareness raising	France, Netherlands, Sweden, UK

4 Barriers, opportunities and final recommendations

4.1 Barriers to the repair of electronic devices

A large share of the population does not repair digital devices when they are broken. For instance, only 62% reported repairing their mobile phones the last time it was broken[97]. There are three levels of obstacles to repair: 1) fundamental legal and non-legal barriers preventing accessible repair; 2) the total price of repair and other competitive factors deterring consumers from choosing repair as an economic option; 3) consumer preferences and attitudes not favouring repair[98]**.** Such barriers can be of technical, economical, legal, cultural, social, psychological, and political natures.

An **inadequate legislative framework**, notably in intellectual property law, contract law, or in relation to liability, can result in preventing repair or making it less attractive (see section 4.1.1.). Consumers may lack information on their rights. The internal market remains fragmented as Member States present specific legislations in this regard[99].

The **design** of electronic devices can create important barriers to repair[100]. They can be due to technical constrains (e.g. security, performance, weight, compaction), but also to deliberate choices by the manufacturer to increase sales (premature and planned obsolescence). Miniaturisation, the choice of materials and components, the fastening methods, as well as the lack of compatibility or modularity in a device affect its fragility, prevent or complicate the disassembly and replacement of parts, and thereby determine the ease with which they can be repaired and upgraded. Software is also sometimes designed only for newer models or include built-in locks preventing unauthorised repair. Even when repair is possible, these constraints make it lengthier and/or costlier, potentially less reliable, leading customers to rather opt for replacement.

There is a **lack of access to fundamental elements required to repair devices**[101]. Manufacturers do not systematically make available original parts, or only at high costs. Alternative spare parts are not always easy to find or of sufficient quality[102]. Takeback schemes for potential reuse of components are not yet usual practice. Besides, as there is a strong lack of standardisation, components tend to be model- or brand-specific. This issue is intensified by the typically short innovation cycles of electronic devices[103]. If available, procuring spare parts is therefore often costly and/or lengthy. In addition, consumers and independent repairers often do not have access to the required information (manuals and schematics), nor to the required tools to perform the repair.

There is a lack of awareness and knowledge as customers do not have **easily accessible, sufficient nor systematic information** on the reparability of the products they purchase, nor on the available repair services (options and locations). They may not be fully informed on their rights as consumers (e.g. regarding the warranty)[104].

Repair can also be **less competitive** than purchasing new products when considering the total **cost** of repair[105], often identified as one of the main barriers for consumers, but also time and inconvenience[106]. This results from a drop in the price of electronics, and to factors increasing costs for repairers (see section 4.1.2). Besides, doubts on the quality of the repair service or on the reliability of repaired products can also make repair a less attractive option[107]. The additional constraints brought by reparability to the design of a product might come at the cost of performance, giving non-reparable devices an advantage[108]. New devices may have more attractive functionalities and design, encouraging replacement rather than repair.

Cultural, social and psychological aspects influencing consumer preferences and attitudes, such as the "throwaway society" can make repair less desirable, independent of costs and other barriers[109]. Some products such as smartphones are more likely to be disposed of even though they still function, due to a

[97] European Commission (2018)
[98] Svensson et al. (2018)
[99] European Commission Evaluation of EU legislation on design protection
[100] Deloitte (2016)
[101] McCollough (2010); Pérez-Belis et al. (2017); Sabbaghi et al. (2017)
[102] Deloitte (2016)
[103] Deloitte (2016); Svensson et al. (2021)
[104] Hernandez et al. (2020)
[105] European Commission (2018);
[106] Wieser et al. (2018); Sabbaghi et al. (2018)
[107] Deloitte (2016)
[108] Cordella et al. (2021b)
[109] McCollough (2010); Wieser et al. (2018)

limited social lifespan and changing trends[110]. The contemporary consumer culture, with an abundance of low priced (and often low quality) products, reduces the emotional attachment and in turn the efforts to maintain and repair products[111].

The following sections will focus on legal barriers, and barriers affecting the supply of repair services.

4.1.1 Legal barriers

There are several legal hurdles that need to be tackled to allow for an effective implementation of the right to repair.

One major legal barrier is posed by intellectual property law, limiting the access to information, use and production of spare parts and repair itself. With 27 different national laws on IP as well as the European Intellectual property rights, an EU-wide assessment of potential barriers is challenging.

Intellectual property law spans several categories, including patents, trademarks, trade secrets, designs and copyright.[112]

While intellectual property protection is vital to ensure a product is not illegally copied, reproduced or sold, it can limit the ability to repair a product or to replace some of its parts. In some cases, patents (utility and design in the U.S.), trademarks, copyrights and trade secrets are "*wielded to shield products, product components, knowledge, and information from the public in order to keep repair within the manufacturers' control*"[113]. This leads to distortions in competition, high prices for spare parts and limited access for independent repairers. Certain specific barriers arise for the right to repair a product within each of these categories.

The EU's internal market remains fragmented as Member States present specific legislations in this regard[114].

4.1.1.1 Trade marks

In principle, after a product is sold in the European Economic Area, the trade mark owner has exhausted his or her rights to the product unless there are specific concerns (e.g. about the safety or brand image of the product) when it is further commercialized, e.g. after repair has taken place. This means that the purchaser is allowed to resell the product once he or she has legally obtained it. In some judgements that were referred to the CJEU for clarity, questions about differentiation between collective or individual marks, possible objection to commercialization even after a former trade mark was removed and potential technical standards to be met after repair were raised[115]. Notably, the recent court case of Huseby v. Apple Inc.[116], in which an independent Norwegian repair store lost an appeal by Apple for selling refurbished Apple IPhones using unapproved refurbished screens (which were claimed to wear an unlawfully appropriated Apple trademark), highlighted the challenges of the repair market created by trademark law. The Right to Repair movement highlighted the need to allow the use of refurbished screens for reasons of sustainability and for the right to repair itself, as large corporations otherwise have the ability to control the spare part market.[117]

4.1.1.2 Copyright

In order to repair products, and to replace certain hardware components, the software of a product that is copyright-protected might need adaptation, e.g. if it does not recognize the new hardware component. This is currently oftentimes only possible if the original manufacturer provides the digital key, thus limiting the

[110] European Commission (2018); McCollough (2010); Pérez-Belis et al. (2017); Sabbaghi et al. (2017)
[111] Chapman (2005)
[112] The European Union Intellectual Property Office (EUIPO) defines these categories as follows:

- **Trade marks** signal the origin of products to consumers.
- **Trade secrets** refer to information that has commercial value because it is secret (such as new manufacturing processes, recipes, chemical composition). There is no limit to their duration.
- **Designs** specify how products look like.
- **Copyright** relates to artistic creations, such as books, music, paintings, sculptures and films.
- **Patents** protect technical inventions in all fields of technology.

[113] Grinvald, & Tur-Sinai (2020), p. 100
[114] European Commission Evaluation of EU legislation on design protection. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1846-Evaluation-of-EU-legislation-on-design-protection_en
[115] Dorenbosch (2020)
[116] Supreme Court of Norway (2020)
[117] Claburn(2020)

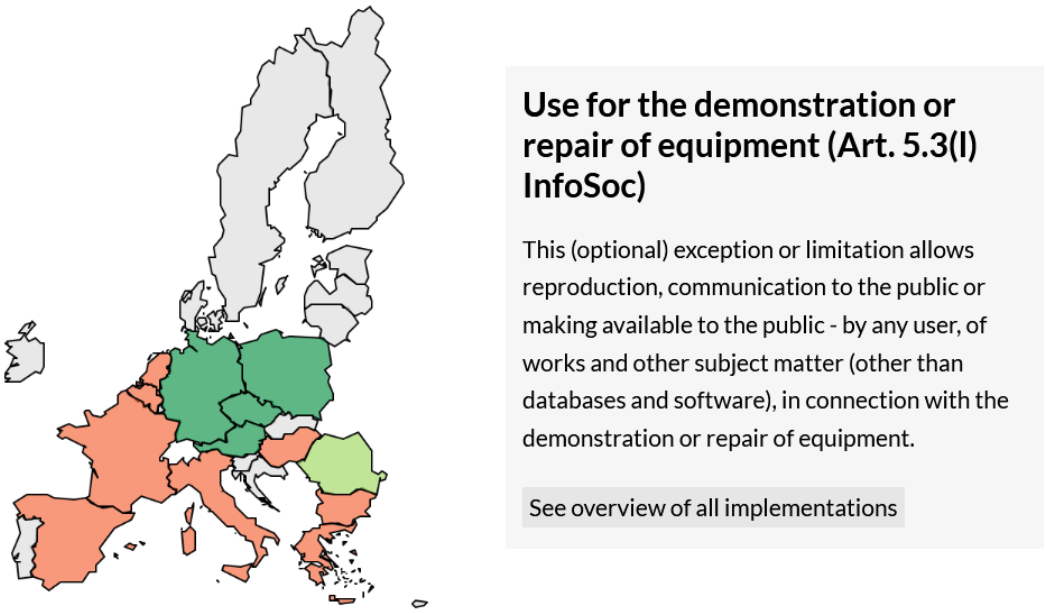
possibility of independent third-party repair. [118] While the Directive on the legal protection of computer software allows for correction of faulty software to re-establish the intended function, enhancement is generally prohibited (thus, connecting it with different hardware parts).

In October 2021, the European Court of Justice ruled that in the case of individual repair of a software, the licensee is permitted to repair and disable the non-functioning programmes.[119]

One particular issue in this respect is the contracting out of copyright exemptions. Advocates for the right to repair in Australia, the Creative Commons community for instance, have urged for open licencing terms to allow for fair and open access to information needed for the repair of a product. It is argued that this actually improves security of the devices as this adds an additional level of independent auditing and analysis.[120]

Copyright also stretches to official repair manuals and documentation, without which independent repair is difficult or impossible. One example can be seen with the platform iFixit that offered a medical repair data base based on the collection of repair manuals for more than 13 000 ventilators and other medical devices during the pandemic to make repair easier for independent medical technicians. However, when manuals contained copyrighted material, original equipment manufacturers often asked to remove the documents from the website.[121]

Figure 14. Copyright exemptions for repair and demonstration purposes in the EU (Source: copyrightexceptions.eu)



The above visualization by CopyrightExceptions shows the lack of harmonization in the existing Copyright Directive (2001)[122]. Countries in dark green fully implemented an exemption from copyright restrictions for demonstration or repair of equipment, countries in light green have a partial exemption, and countries in red offer no exemption. This is due to the facultative nature of implementing the different exemptions within the Copyright Directive across member states.

For a more homogenous approach across member states these provisions would need to become obligatory across the entire Union. For instance, the Directive on Copyright and the Digital Single Market (2019), applied a more homogenous approach for the three new exemptions that were introduced with regards to text and data mining, use of works in digital cross-border teaching activities and for preservation of cultural

[118] Geist (2021)
[119] Judgment of the Court of Justice of 6 October 2021, C-13/20.
[120] Rimmer (2021); Ruhrmann (2021)
[121] Rimmer (2021)
[122] Directive 2001/29/EC

heritage[123]. This was done by making these exceptions mandatory across all member states of the European Union.

4.1.1.3 Contract law

Many terms in End User Licence Agreements (EULAs) and conditioned sales contracts forbidding unauthorized repair or modification can be enforceable under contract law - de facto circumventing the exhaustion doctrine that would normally apply to IP rights once the product was sold. EULAs are common for software-enabled devices, while conditional sales contracts are generally used for, e.g. machinery and vehicles. In the U.S., violation of such terms constitutes a breach of contract. The utilization of contract terms to restrict repair has arguably been 'normalized' by the Supreme Court[124] and is upheld by a decade of court rulings that have predominantly backed the use of EULAs, despite casting doubt on their enforceability[125]. Similarly, the United States Copyright Office (USCO) identified no barriers to the enforcement of contractual terms under state law, 'regardless of the resolution of those copyright issues'. In the case of an independent repairer performing a repair, any contractual claim must be directed to the customer who employed the independent repairer, as the independent repairer is not in contractual privity with the seller of the product.[126]. On the contrary, in the EU, contracts cannot usually override the exhaustion doctrine. The possibility to pursue a non-party of a contract (e.g., a manufacturer pursuing an independent repair for a breach of its contract with the user) varies greatly depending on the legislation of the EU Member State.

4.1.1.4 Designs

Design rights or patents covering a product can also hamper the repair process.

This aspect is dealt with in more details in the complementary Sustainable Products Initiative, which will revise the Ecodesign Directive, to allow for better repair and reuse of products and to increase information on the sustainability of the product Design rights or patents covering the use of a product can also hamper the repair process.[127]

When it comes to the design of products, spare parts which are protected by design law cannot be legally replicated unless a repair clause is introduced, preventing such protection. There is already a transitional repair clause contained both in the Design Directive and in the following Community Design Regulation of 2001, the latter giving unitary protection to designs in all EU member states. Its Article 110 provides that protection as a Community design shall not exist for a design which constitutes a component part of a complex product used within the meaning of Article 19(1) for the purpose of the repair of that complex product so as to restore its original appearance. However, this was introduced as transitional clause and member states could retain their existing laws on the protection of spare parts until. Critics point out that the introduction of this clause did not have much of the intended effect, as national contract and IP laws in many member states in practice created barriers to access repair services and to obtain spare parts.[128] Updates on EU rules for design protection are expected for the end of 2022. The revision aims at a full liberalization of the aftermarket of products and fair competition for independent spare part providers by introducing a repair clause to the revised Design Directive and the Community Design Regulation.[129]

4.1.1.5 Patents

In principle, simple repairs of patented goods are allowed in most countries. Australia, for instance, applies a doctrine of exhaustion of rights after the sale of a product, meaning that the original manufacturer can no longer exert restrictions on the use of a patented product after its sale, including repair of the product.[130]

This becomes a grey zone for refurbished or remanufactured products as while repair is allowed reconstruction usually is not.[131] Using patented or non-patented spare parts could also be a decisive factor

[123] Directive (EU) 2019/790
[124] Gomulkiewicz (2018); U.S. Supreme Court (2017).
[125] Gomulkiewicz (2018); Perzanowski and Schultz (2016)
[126] Gomulkiewicz (2018); McSherry and Walsh (2017).
[127] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12567-Sustainable-products-initiative_en
[128] Ecommerce Europe (2022)
[129] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12609-Intellectual-property-review-of-EU-rules-on-industrial-design-Design-Directive-_en
[130] Ruhrmann (2021)
[131] Courage et al. (2021)

whether repair is allowed or seen as an infringement of IP law.[132] The need to use patented spare parts or allow for third parties to produce parts needs to be clarified in regulation on product design.

4.1.1.6 Legal ownership and products as a service

One important aspect of the right to repair is the question of legal ownership that brings along the right to resell or repair the product. However, new circular business models experiment with the concept of product as a service, offering leasing contracts for electronic consumer goods, and thus retaining the responsibility and ownership over the product.[133] New legislation should thus also take these developments into account.

4.1.1.7 Product safety and liability law

There is some uncertainty on the status of repaired products under EU product safety and product liability law[134]. The question of product liability comes into play for instance if a part of the device is replaced by spare part manufactured by a different party, or if the repair service is performed by an independent entity. According to the Product Liability Directive it is the manufacturer that is liable in case of a defective product. Introducing a right to repair would allow reparations by independent repairers or consumers, including reparations significantly altering products. This raises the question of who would be considered the 'manufacturer' (i.e. original equipment manufacturer or repairer) and who is thus liable in case of product damage or an accident following repair or refurbishment of a product[135]. Extending the product lifespan could increase the likelihood that products develop faults, which may also lead to increased claims against manufacturers[136].

4.1.1.8 Conclusion

What can be seen from the different areas of intellectual property right is that the right to repair needs to be well connected to any design directives and regulations to allow for exemptions for repair and for the usage of spare parts. Copyright on software, including digital locks, and on repair manuals poses another IP issue that needs to be taken into consideration. Finally, exemptions on IP law have to be broad enough to allow for repair and refurbishing of products. Exemptions should be harmonized, thus, ideally compulsory, across the Union. In addition, existing exceptions should not be used against repair services.

4.1.2 Barriers and enablers affecting the supply of repair services

The supply of repair services has a crucial impact on the extent to which products in general, and digital devices in particular, are repaired. The choice of consumers to repair their devices will indeed largely depend on whether they can find accessible and competitive repair services. It is therefore important to analyse the conditions affecting the supply of repair by different players.

4.1.2.1 Trends in the repair sector

The repair sector in the EU as a whole has grown from 2012 to 2018 by a modest rate of 14.6%, slower than the EU's GDP (i.e. 18.8%)[137]. The overall number of employees repairing computers and personal and household goods in the EU increased from about 387 000 to over 410 000 between 2012 and 2017[138]. There are strong variations between EU Member States. The number of repair businesses in the sector of repair of computers and communication equipment (e.g. mobile phones) varies from 2.74 per 10 000 population in Lithuania to 0.16 in Luxembourg. While understanding the reasons for this variability would require further analysis, the number of repair businesses per habitant tends to be lower in countries with a higher GDP per capita (figure 14), which is consistent with the finding that willingness to repair decreases with rising wages[139]. The evolution of the turnover of the IT repair sector between 2012 and 2018 is strongly contrasted between countries (figure 15), with decreases in some countries (e.g. -34.8% in Sweden, -21.8% in France, -13.2% in Italy), stagnation in some (e.g. 0.4% in Germany), and increases in other (e.g. 54.9% in Poland, 76.3% in Belgium). It is harder to distinguish geographical or economic trends underlying this diversity.

[132] McKee Voorhees & Sease PLC (2021)
[133] Graat (2021)
[134] Van Gool (2021)
[135] COM (2018) 246 final
[136] Pinsent Masons (2021)
[137] Eurostat (2022)
[138] Eurostat (2020)
[139] McCollough (2010)

Figure 15. Number of IT repair companies and GDP per capita European Union, 2018 (Source: Eurostat)

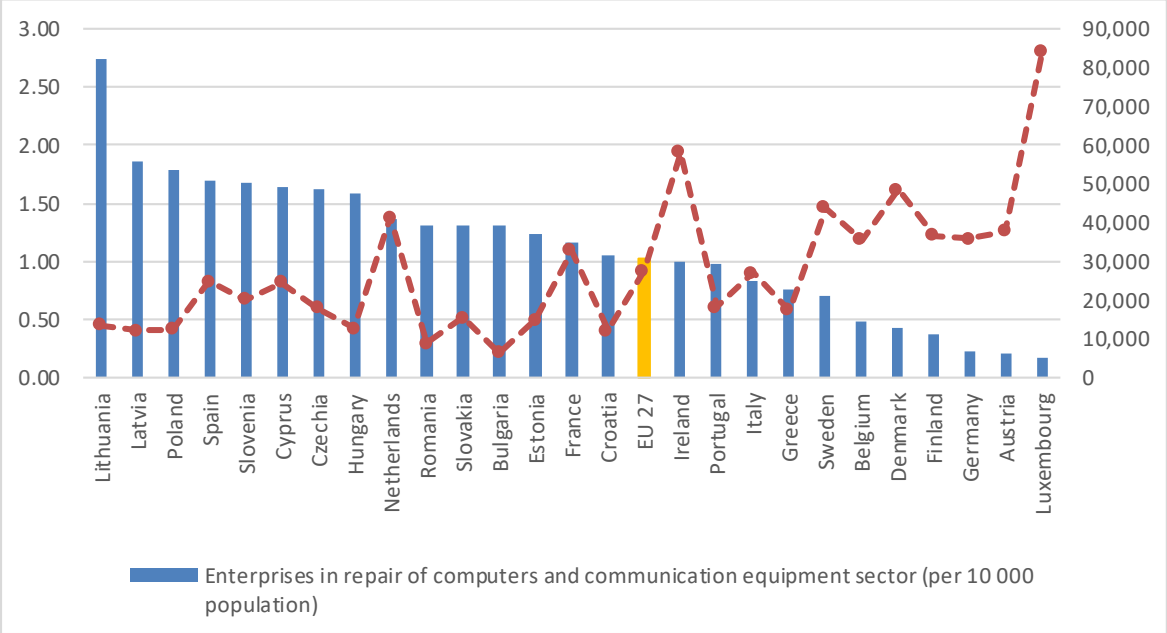
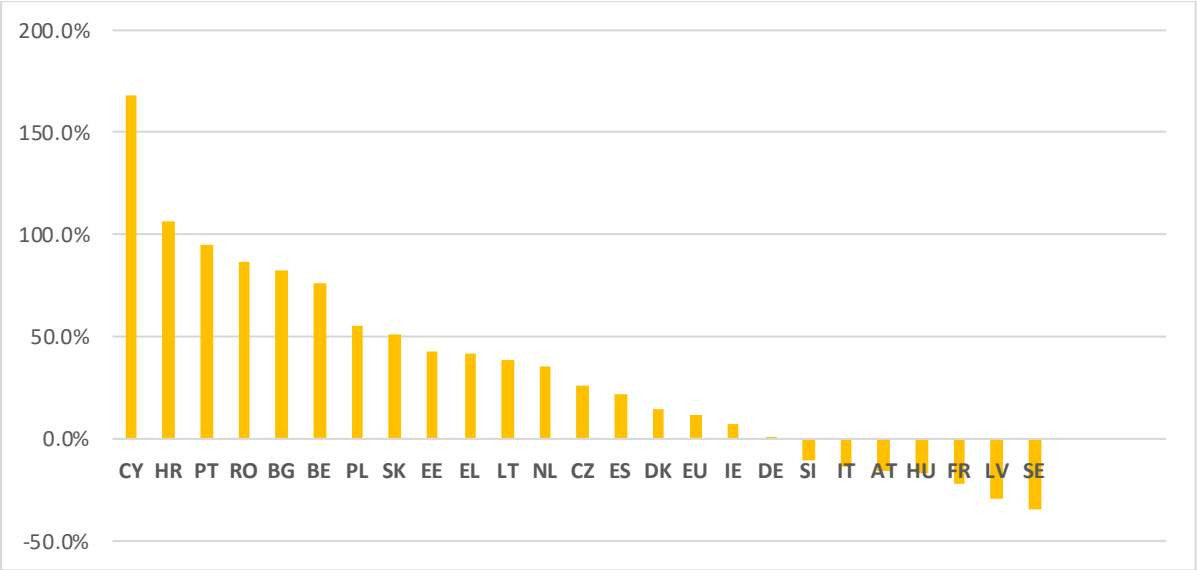


Figure 16. Evolution of the turnover of the IT repair sector between 2012 and 2018 (Source: Eurostat)



4.1.2.2 Barriers and enablers affecting the competitiveness of repair

Repair activities, in general, suffer from barriers linked to consumer choice. The increasing reliance on mass production, automation and cheaper overseas labour for the manufacturing phase has led to a drop in prices in many products. By contrast, repair activities are labour-intensive, tailored, and need to be done locally to ensure timely repair. This has reduced the price difference between repairing a product and buying a new one and made repair a less competitive option, particularly in Western Europe where labour costs are higher.[140] The price of repair is indeed one of the main reasons for not repairing products. For example, it was indicated as a reason not to repair a mobile phone by 39.8% of respondents, the largest share, in a survey on 12

[140] Sabbaghi et al. (2018); Wieser et al. (2018)

European countries[141]. According to another study, the falling prices of mobile phones is perceived as a threat to their business by 43.8% of independent repairers in the Netherlands, and 38.5% in Poland[142]. Economic conditions, as well as common industrial and fiscal policies (e.g. R&D, large investments, public-private partnerships), may also be more favourable to capital-intensive circular practices, like recycling or recovery of sorted materials, than to labour-intensive ones like repair[143].

These issues affecting the competitiveness of repair may be less prominent for smartphones[144]. Phones are relatively expensive, increasing the willingness to pay for repair and maintenance services. They are very widespread and relatively fragile[145], increasing the demand for repair. Another driver is that repairing a smartphone allows the user to save time on the customisation of apps. These factors make smartphone repair a viable business response to an economic opportunity. The sector is nevertheless highly competitive, which, together with the high price sensitivity of the demand for repair and important costs, tends to reduce profit margins. In the Netherlands and Poland, repair businesses identify competitive pressure from new repair shops and informal repair activities as the main threats they are facing[146]. Many repair business still show optimism on the future of the market[147]. The 17.9% increase in the number of enterprises in the repair of communication equipment sector between 2012 and 2019 in the EU (compared to only 2.5% for the repair sector as a whole)[148] supports this assessment. By contrast, the number of enterprises in the IT sector as a whole decreased by 0.9% due to a reduction of computer repair companies. However, the trend is reversed when looking at the evolution of the turnover: while it increased by 14.6% for the whole repair sector between 2012 and 2018, it grew by only 8.5% for communication equipment repair. Some potential explanations for this paradox are low profitability levels and the prevalence of undeclared activities[149], but this would require further analysis.

4.1.2.3 Business models offering repair services

The repair sector is highly fragmented, with a variety of players offering repair services. Firstly, consumers can repair their devices through original equipment manufacturers (OEMs), retailers or, for smartphones, network operators. This is the most common option when the product is still under warranty[150]. In some cases, manufacturers have internalised repair service, but they generally rely on external authorised repairers. For smartphone repair, official repair channels tend to offer poor customer value[151]. They are relatively expensive and time consuming (e.g. one to three weeks in Denmark[152]). Consumers often have to send their phone by mail and cannot speak directly to the repairer. The main interest of OEMs and retailers is to increase volumes of sales, limiting their incentives to optimise and develop repair services[153]. For example, in a communication to its shareholders, Apple presented the slowing demand for new products and the increased use of iPhone battery replacement as a reason for lower revenue[154]. As there is an information asymmetry between the OEM performing the repair service, who has greater knowledge of the required parts and activities, and the customers, there is a risk, or at least a perception, that customers are overcharged[155]. The Chinese situation, where the strong competition between phone manufacturers has led them to offer good after-sale services, including rapid response maintenance teams, shows that OEMs can, in certain circumstances, have incentives to offer good repair services[156].

A second option for consumers is to use the services of independent repairers. These repairers are either authorised partners of the manufacturer, which can use their services during the warranty period, or non-authorised repairers. For repairs not under the warranty, repairers are typically independent[157]. Independent

[141] Austria, Netherlands, Sweden, Czech Republic, Germany, France, Ireland, Hungary, Latvia, Spain, Portugal and Romania. European Commission (2018)
[142] Türkeli et al. (2019)
[143] King et al. (2006); Llorente-González et al. (2020)
[144] Türkeli et al. (2019); Riisgaard et al. (2016)
[145] Laitala et al. (2021)
[146] Türkeli et al. (2019)
[147] Türkeli et al. (2019); Riisgaard et al. (2016)
[148] Eurostat, 2022
[149] Türketli et al. (2019)
[150] ADEME (2018)
[151] Türkeli et al. (2019); Riisgaard et al. (2016)
[152] Riisgaard et al. (2016)
[153] Türkeli et al. (2019); Riisgaard et al. (2016); Maitre-Ekern and Dalhammar 2016
[154] Cook (2019)
[155] Kerschbamer et al. (2017)
[156] Türkeli et al. (2019)
[157] ADEME (2018)

repairers are mostly small, often one-person companies focusing on business-to-consumer (B2C) services. Larger structures also have lasting contracts with companies, schools or municipalities[158]. Independent repairers can provide high customer value propositions[159]. Their advantages include a local presence, direct contact with customers, more competitive prices and faster repair. They often offer complementary accessories and customised services to customers, such as advice on usage, software update and recovery, mobile phone call credits, data-related services or second-hand repair and sale activities. This helps to sustain the trust of customers and their position on the local market[160]. The initial capital needs to establish a repair shop is quite low. Finally, professionals of sales of refurbished products (e.g. REMADE, Backmarket) also offer repair services, but with a view to re-sell the products to other consumers.The ecosystem for repair services largely composed of small and medium-sized enterprises (SMEs). According to Eurostat, 98.4% of all enterprises in the repair of computers and personal and household goods sector were classified as micro enterprises with less than 10 employees. Another trend in the repair sector is the development of social enterprises that intervene on the flow of waste, helping to put repaired products back on the market[161].

Numerous new actors have entered the refurbishment market, attracted by fast growth and high profits. But this fast growth is not always positive from the environmental or social perspective. A good illustration is the emergence of major players in refurbishment, capable of bulk buying batches of second-hand smartphones, less than six months old, in the USA and Japan where renewal rates are very high, sending them to Asia or to low-cost economies for repair before selling them in Europe. This system primarily props up the market for new products and creates very few jobs regionally.

4.1.2.4 Barriers and enablers related to factors of production

Repair businesses, especially independent repairers, are strongly affected by barriers making repair technically infeasible. They often have difficulties finding the required spare parts and ineffective design can prevent disassembly (e.g. glued components)[162]. In a study on independent repair businesses in Denmark, Riisgaard et al. (2016) find that more than half of the respondents say that a main barrier for their business is getting the original spare parts. Repairers often favour original spare parts who tend to be more durable. Even when accessible, these original spare parts are often expensive, undermining the profitability of repair businesses. The increased complexity, miniaturisation and deliberate design choices have made smartphones harder to repair, especially for certain brands. Türkeli et al. (2019) find that 58.8% of repair shop owners in the Netherlands, and 69.2% in Poland, believe that phones have become more difficult to repair. Rapid changes in the design and components of products, often without real changes in functionality, as well as the large range of available brands and lack of interoperability of components, including between products of the same brand, create further obstacles for repair businesses.[163]

Another challenge for repair businesses if finding skilled workers. For smartphones, the basic technical skills required to perform repair are relatively easy to learn[164]. While many employees in the smartphone repair sector have a technical education, a large share of them describe themselves as self-taught.[165] This prevalence of self-teaching results from the constant evolution of devices, but also from a lack of qualification and vocational training[166]. Some training is offered by certain OEMs, by networks of professional repairers or by structures in the social economy[167]. Rapid advances in digital devices technologies, new designs making repair more difficult and diverse brands and models require continuous training, and access to the necessary information (i.e. manuals, schematics), which represents a significant cost and challenge for repair businesses[168]. Another issue is the lack of attractiveness of repair jobs, with a perception in the industry that too few young people choose this career. A lack of competent personnel could make it difficult for businesses to address growing needs, and discourage customers from repairing their devices if they cannot find available repairers or need to wait longer[169]. This lack of attractiveness could result from unfavourable

[158] ADEME (2018); Riisgaard et al. (2016)
[159] Türkeli et al. (2019)
[160] Türkeli et al. (2019); Riisgaard et al. (2016)
[161] ADEME (2018)
[162] Deloitte (2016)
[163] Deloitte (2016)
[164] Türkeli et al. (2019)
[165] Türkeli et al. (2019); Riisgaard et al. (2016)
[166] Deloitte (2016)
[167] ADEME (2018)
[168] Türkeli et al. (2019)
[169] Laitala et al. (2021); Deloitte (2016)

conditions. Low margins make it difficult to offer higher wages. Repair workers, notably for smartphones, are less and less salaried and increasingly self-employed. In France, the number of salaried jobs for phone repair decreased by 10% between 2012 and 2017, while it increased by 99% for non-salaried jobs[170]. The asymmetry of power between large OEMs and small independent repairers can lead to situations where independent repair workers are in practice outsourced employees from OEMs under "covert, precarious work relationships"[171]. Many immigrants are active in the sector[172], which could illustrate the low attractiveness of repair jobs, as immigrants often fill jobs in manual and labour-intensive sectors that have difficulties recruiting natives[173].

Certain regulations can create barriers for repair businesses. For example, while the use of used components for repair could have significant environmental benefits, Riisgaard et al. (2016) find that only few companies choose this option. Repair service providers are indeed required by EU legislation to provide a warranty period equivalent to new products (two years) but using used part can cause uncertainties on the long-term performance or the repaired device, creating a risk for the repairer.

Certain taxes can also affect repair activities. Taxes on refurbished spare parts can also make them less competitive in terms of cost compared to new parts manufactured in low labour costs and low tax countries[174]. For example, Sweden introduced a tax on flame-retardant in electronics to promote substitution for hazardous materials. It applies to refurbished electronics remanufacturers, who cannot substitute the materials and must thus incorporate this tax in their products' price.

4.1.2.5 Barriers and enablers related to consumer trust and information

Aspects related to the trust and awareness of customers have an important impact on the supply of repair services. The growing awareness of consumers and interest in repair is a key driver for the repair sector[175]. The fragmentation of the repair market can however make it harder for customers to find repair services. According to a survey in Germany, 23% of repair workshops consider that better information to consumers on repair would be the most impactful measure to help the sector.[176] Consumers can also have uncertainties on the quality of repair services. The trust in repair services is shaped by past experience. A survey on 12 European countries finds that over 70% of consumers of repair had "their expectations in terms of convenience, speed, quality and friendliness" met, or even exceeded. This suggests that mostly positive experience of repair could be driver for repair demand.[177] However, price-based competition may come at the expense of quality, in turn reducing the confidence of consumers and their willingness to choose repair[178]. The provision of warranty on repaired products, following EU legislation, can reinforce the trust of consumers. Federations of repair businesses can play an important role by providing means to find good quality repair offers. Rating and comparison services can help consumers find reliable repair businesses. Having a physical shop can also help reinforce the trust of customers[179].

4.1.2.6 Community repair and social economy

An important recent trend is the rapid progression of self-repair, although it remains marginal (less than 1% in France[180]). Self-repair is supported by online platforms providing information on DIY repair (e.g. iFixit), and by community initiative such as the Repair Cafés, which originates from the Netherlands and is present in more than 11 countries. A common model for such initiatives it to allow people to bring their broken products and to offer them advice from knowledgeable volunteers, tools, space and spare parts. The self-repair sector is particularly developed in the Netherlands and Belgium, with around 2 repair cafés per 100 000 inhabitants[181]. In Belgium, regional federations[182] are helping create a global dynamic. The most popular products for self-repair are the ones with few professional repairers (e.g. small kitchen and household appliances, lamps and lighting, clothing, etc.). People engaging in self-repair are often driven by environmental

[170] ADEME (2018b)
[171] Llorente-Gonzalez and Vence (2020)
[172] Türkeli et al. (2019)
[173] Constant (2014)
[174] Svensson et al. (2021)
[175] Richter et al. (2019)
[176] Vangerow-Systermwerkstätten, February 2015.
[177] European Commission (2018)
[178] Svensson et al. (2021)
[179] Riisgaard et al. (2016)
[180] ADEME (2018)
[181] ADEME (2018)
[182] Netwerk Bewust Verbruiken for Flanders, and RepairTogether for Wallonia et Brussels

objectives or sentimental value[183]. Laptop computers, tablets and mobile phones are less frequently repaired in Repair Cafés[184]. Self-repair initiatives are therefore complementing repair businesses rather than competing with them and can contribute to increasing the demand for repair by raising awareness. The positive repair experience combined with increased knowledge on sustainable practices obtained in Repair Cafés can lead to a reduction of skepticism toward repair[185]. Richter and Dalhammar (2019) find that the majority of professional repairers in Southern Sweden had positive views of DIY and community repair. Support by local public authorities is often essential for the sustainability of community repair.

4.1.3 Political enablers and barriers

4.1.3.1 Broad and diverse supporting movements

While it has more ancient roots, the movement supporting Right to Repair (R2R) legislation has progressively gained momentum since the 2000s. The wide use of smartphones and the restrictive policies of manufacturers like Apple has contributed to this development[186]. Grassroots movements like the Repair Cafés, launched in the Netherlands, have helped develop networks and communities of sensitised people across the world. One strength of the movement has been its capacity to mobilise diverse stakeholders. The social movement for repair brings together environmentalists, mechanics, farmers, scientists, consumer rights advocates, small and large businesses (repair-related or not) and individuals, as illustrated by the diverse membership of the Repair Association in the US or of the Right to Repair Europe network[187]. While more present in Western and Northern Europe, such movements exist across the EU. The actors have complementary objectives and motivations. For example, environmentalists tend to focus on the potential to reduce electronic waste or greenhouse gas emissions and small businesses or independent repairers on the need for fairer competition and more affordable repair. Farmers have been very active advocates, denouncing the policies of companies like John Deer preventing them from repairing their farming equipment. Disability activists have also supported the R2R, arguing that it is essential, for example to make it possible to rapidly fix electric wheelchairs[188]. This ability to draw on different narratives has helped obtain widespread support. In the US, where the values of property and autonomy are strongly rooted, the debate has focused a lot on consumer rights ("we just want to fix our stuff"[189]), giving the notion strong bipartisan support[190]. In Europe, the discussion has been more linked to the promotion of circular economy concepts and to the green transition. The concept of repair appeals to different ideologies. While the dominant framing of repair, at least in Northern countries, is technocratic and market-oriented, with a focus on consumer choices and on repair by specialists, a more radical understanding, rejecting consumerism and productivism, is defended for instance by community-based "do-it-yourself" repair movements[191].

4.1.3.2 Powerful opponents with important lobbying resources

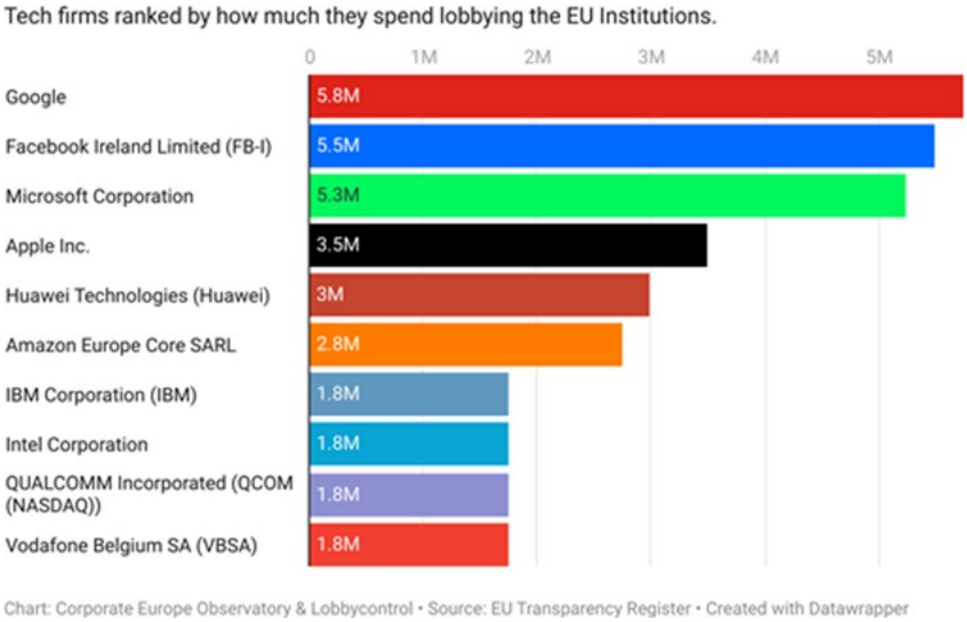
Despite of a widespread support and a political momentum, right to repair legislation has faced strong political barriers, mainly due to the opposition of large companies. The consideration of right to repair legislation by various US states has faced intense lobbying efforts, especially by Apple and Microsoft. For example, in the state of Washington, Microsoft told lawmakers it would stop selling Surface Tablets if the bill passed, calling it an "existential threat." In the same state, Apple discreetly told elected officials that it would endorse repair programs at local colleges in exchange for killing the bill, according to the Representative who introduced the text[192]. While large technology companies (Amazon, Apple, eBay, Facebook, Google, Microsoft) have been the most vocal opponents, either through their trade association or directly, companies from other sectors have also opposed the measures, such as telecoms (AT&T, T-mobile), home appliance firms (Philips), medical equipment (General Electric, Johnson & Johnson, Medtronic, Lilly Inc.), farm equipment (John Deere), construction (Caterpillar) and automotive (Tesla)[193]. The main concerns raised by these companies are related

[183] ADEME (2018)
[184] Repair Cafés© (2016), cited in ADEME (2018)
[185] Wieser et al. (2018)
[186] Hatta (2020)
[187] Our network - Right to Repair Europe
[188] Gault (2021)
[189] Proctor (2019)
[190] According to a 2019 poll focusing on farm equipment, 65% of Democrats supported the Right to Repair, and 75% of Republicans. Proctor (2019).
[191] Niskasen et al. (2021)
[192] Bergen (2021)
[193] U.S. PIRG (2021)

to intellectual property, consumer and repair worker safety, cybersecurity, privacy, warranties, liability, and reputational harm[194].

The opposition of the digital industry in the EU could be a significant political barrier. The digital industry as a whole spent €97 million lobbying the EU and employs 1452 lobbyists on its behalf. Google (€5.8 million), Facebook (€5.5 million) and Microsoft are the top spenders in Brussels, while Apple or Huawei are also investing major amounts. [195] The digital industry is also funding a large network of think tanks, SME and start-up associations and law and economic consultancies in a way that is not always transparent. It has a strong influence on certain EU capitals.

Figure 17. Top 10 digital industry lobbyists (Source: Corporate Europe Observatory et al. 2021)



Recent evolutions suggest large digital companies are becoming more open to the Right to Repair. In 2019, Apple introduced the "Independent Repair Provider" program, providing repair shops with access to device parts, tools, manuals and diagnostic information for out-of-warranty devices. Initially started in the US and Canada, the programme expanded to Europe and recently to more regions internationally[196]. In November 2021, it announced it would give access to consumers to a limited number of spare parts (screen, battery and camera), tools and manuals for certain products, starting in the US in early 2022 and expanding to Europe later in 2022[197]. It also recently removed software locks preventing independent repairers and users to change screen of iPhone 13 but hasn't committed to do so for all products. In October 2021, Microsoft also announced it would launch an independent study on the environmental and social impacts of facilitating repair by consumers and identify mechanisms to increase access to repair, like expanding the availability of certain parts and repair documentation beyond authorised repairers. [198] This commitment followed a resolution by shareholders, supported by a non-profit specialising in shareholder advocacy. Similar right-to-repair resolutions have been filed with Apple and Deere & Co by Green Century, a mutual fund company focused on environmentally responsible investing[199]. Such policies by Big Tech companies, however, may be an attempt to ease down pressure and promote soft rules, shaped by themselves, instead of more constraining regulation. This would correspond to a recurrent strategy of Big Tech[200].

[194] Bergen (2021)
[195] Corporate Europe Observatory et al. (2021)
[196] Fathi (2021)
[197] Repair Together (2021)
[198] Gault (2021b)
[199] https://www.greencentury.com/green-century-files-shareholder-proposal-with-deere-co/ and https://www.greencentury.com/green-century-shareholder-proposal-presses-apple-to-expand-access-to-repair/
[200] Innocente (2021)

4.1.3.3 A political momentum

Encouraged by the repair movement, many laws have been considered or introduced, both in the US and Europe. In the U.S., 27 states had considered or were considering right to repair bills in 2021. More than half were however voted down of dismissed[201]. In June 2021, for the first time, a U.S. representative from New York introduced a national right-to-repair bill targeting everything from computers to tractors. In July 2021, following a Federal Trade Commission (FTC) report in favour of promoting repair, President Biden issued an executive order asking the Federal Trade Commission to develop new rules addressing "unfair anticompetitive restrictions on third-party repair". The pandemic reinforced pro-repair arguments, by exacerbating the effects of repair restrictions on consumers, particularly on hospitals who could not repair their medical equipment and on disadvantaged communities[202], fuelling issues like shortages of school laptops[203]. In Europe, several Member States have introduced legislation, anticipating EU regulations. A noteworthy recent example is the French law on reducing the footprint of digital" (see Box 1 below).

Box 1. French Law aiming to reduce the environmental footprint of digital technologies (Loi REEN[204])

Initially drafted by Senators, the text was strongly watered down by the National Assembly, in agreement with the government[205]. Certain ambitious measures with the potential to increase repair, such as an extension of electronic devices' legal warranty from two to five years, rules to ensure consumers can easily replace their phones' batteries and a deposit scheme on digital devices were voted down by MPs. Following a fierce lobbying battle between the refurbished goods industry and the cultural sector, the private copying levy - a compensation scheme paid to creators and producers on the sale of electronic devices capable of recording cultural content – was finally imposed on refurbished smartphones and tablets. The government successfully asked lawmakers to reject a reduced VAT rate for refurbished devices, arguing that the list of goods that can benefit from reduced VAT rates is determined at EU level. The final text, voted on 10 June 2021, focuses notably on information obligation for consumers on software updates, and on awareness-raising in schools and engineers' training. Companies that refurbish devices will have better access to spare parts, and government services will have to favour reuse of unused IT devices.

The discussions around the law and reduced ambitions of the final text revealed interesting political dynamics. Network operators were successful in lobbying against certain measures[206]. The opposition of the cultural sector proved to be a decisive political factor, showing the need to anticipate adverse effects of measures promoting circular activities on other sectors. According to Frédéric Bordage from GreenIT (a group of green tech experts) "*Political and economic decision-makers still perceive the ecology as something costly and burdensome, and this is why the Senate text's ambitions were lowered*" [207]. A coalition was however formed between refurbishers, with the backing of environmental organisations and France Digital (startup organisation), which could become a new force in future debates.

4.2 Benefits and risks of a right to repair

4.2.1 Environmental benefits and risks

The implementation of the right to repair has a high potential for reduction of environmental impacts, if done correctly.

It has to be pointed out that not all electronic equipment replacement take place because a product is actually broken. Other reasons, such as perceived obsolescence, also play major roles. Following the results of a study conducted in Austria only 30% of replacements were due to broken products.[208] This makes it hard to measure the direct impact of a right to repair in isolation. Factors such as perceived obsolescence, the performance of the phone or behavioural trends need to be considered when looking at potential improvements in the average lifespan of consumer electronics.

In addition, the potential impact of a right to repair, of course, not only depends on the additional lifespan of the product after repair but also the number of new spare parts needed to repair the product. For instance,

[201] Bergen (2021)
[202] Federal Trade Commission (2021)
[203] Bergen (2021)
[204] LOI n° 2021-1485 du 15 novembre 2021
[205] Kayali (2021); Roussel (2021)
[206] Guitton-Boussion (2021)
[207] Kayali. (2021)
[208] Wieser et al. (2018)

circuit boards account for the largest environmental impact of a phone, and thus, a repair that requires replacement of a circuit board would still have high environmental impacts. In most cases, however, the typical elements needing repair are the screen, potentially the casing or the battery, as well as the software or other technical elements.

Cordella et al.[209] (2021) find that, compared to a baseline scenario where smartphones are replaced every two years in a reference time of 4.5 years (resulting in manufacturing and using 2.25 device units), an extension of the lifetime of the device, with repair, leads to a significant reduction of the carbon footprint. With a change of the battery, a one-year extension of the lifetime of the product would lead to a reduction of corresponding greenhouse gas (GHG) emissions by 29% (23% with a display change). A two-year extension, with a replacement of the battery, would allow a reduction by 44% of GHG emissions (40% with a display change).

Table 3. Greenhouse gas emissions over smartphone lifecycle (kg CO2eq). Source: Cordella et al. (2021)

Scenario	4.5 years	1 year	Relative (%)
Baseline (2-year replacement cycle)	77.3	17.2	100
Replacement cycle increased to 3 years	54.4	12.1	70
Replacement cycle increased to 3 years, with battery change	54.8	12.2	71
Replacement cycle increased to 3 years, with display change	59.2	13.2	77
Replacement cycle increased to 3 years, with battery and display change	59.6	13.2	77
Replacement cycle increased to 4 years	42.9	9.5	56
Replacement cycle increased to 4 years, with battery change	43.2	9.6	56
Replacement cycle increased to 4 years, with display change	46.5	10.3	60
Replacement cycle increased to 4 years, with battery and display change	46.8	10.4	61
Purchase of remanufactured device	37.0	8.2	48
Purchase of second-hand device	16.3	3.6	21

With 472 million Europeans having a mobile subscription[210] and thus owning a phone (not counting unused second phones in their homes) this would translate into 8.11 Mt CO_2-eq. of emissions per year in the baseline scenario just from phones. Assuming an extension of the lifetime of the mobile phone by just one year including replacement of the battery and the screen this would reduce annual emissions to 6.23 Mt CO_2-eq. annually for mobile phones alone. Adding another year of lifespan (including battery and display change) would bring this to 4.91 Mt CO2-eq. in emissions. Thus, if repair manages to **extend the lifespan by one year**, emissions could be reduced by 1.9 Mt CO_2-eq.**, equivalent to 1.27 million cars off the road**. Extending the products lifespan by 2 years would save 3.21 Mt CO_2-eq. emissions which is equivalent to over 2 million cars off European roads on a daily basis.[211]

This is coherent with findings by European Environmental Bureau[212] (based on slightly different assumptions) that a one-year lifetime extension of all smartphones in the EU would save 2.1 Mt CO_2 per year by 2030, the equivalent of taking over a million cars off the roads.

[209] Cordella et al. (2021)

[210] GSMA (2021) The Mobile Economy. https://www.gsma.com/mobileeconomy/europe/

[211] In 2020, the average number of kilometers driven per car in the EU was 11 600km (this varies greatly across member states, with 16,400km for Ireland and merely 7,700km for Italy). https://www.odyssee-mure.eu/publications/efficiency-by-sector/transport/distance-travelled-by-car.html. The average CO_2-eq. emission per km in a passenger car in the EU are estimated at 130gCO2/km based on the 2015 target for new passenger cars and assuming averaging out older generations with higher as well as newer generations of fleets with lower emissions. Thus, this would lead to 1,5 tCO_2/car/year.

[212] European Environmental Bureau (2019)

These reduction potentials have to be seen with caution. They are first of all based on estimations. In addition, reduced costs for longer-kept electronic devices could potentially trigger a rebound effect[213], as benefits from the sale of used devices could be partly offset by rebound effects associated with the re-spending of economic savings. For Makov et al. (2018), at least one third of the emission savings resulting from smartphone reuse could be lost because of rebound effects.[214]

Finally, within the loops for a Circular Economy, repair is more efficient than other loops of circular economy. In comparison to repair, recycling requires highly disordered materials and high quantities of energy to separate materials and achieve the quality needed for new products. Recycling also requires more energy than remanufacturing where the primary shape remains. Remanufacturing requires in general more material, energy and labour skill content than reconditioning and repair activities. Thus, if a choice can be made, repair should be the preferred option.[215]

4.2.2 Social and economic benefits and risks

The implementation of a Right to Repair in the EU would have a significant economic and social impact on European economies. In addition to the different impacts detailed in the section, it is worth noting that a more circular economy would reduce the negative external effects on ecological capital[216].

4.2.2.1 Microeconomic impacts

4.2.2.1.1 Consumers

For consumers, the implementation of a right to repair would significantly reduce the life cycle costs of their digital devices. The benefit is two-fold: repair of electronic devices is cheaper than outright replacement, and reparable products maintain their market value for longer, increasing the attractiveness and value of second-hand markets.

A study by Deloitte (2016) found that repair and maintenance have the highest potential to maintain the value of consumer electronics, as repaired products are still valued more than the extracted materials they contained. The economic benefits could be considerable for consumers. With an increased reparability and lifetime of digital devices, consumers would be able to spread the costs of a device over a longer period of time and benefit from a higher re-sale price in second-hand markets.

Design requirements facilitating repair could marginally increase the purchase prices of smartphones, and costs associated to repair (i.e. purchase of spare parts, use of professional repair services) would significantly rise[217]. However, the savings associated to less frequent replacement of devices would largely offset these costs. Apple's experience with its battery replacement program suggests indeed that, given a choice between a low-cost repair and buying a new mobile phone, many consumers opt for the former[218]. Cordella et al (2021) find that a one-year lifetime extension (with a battery replacement) would decrease life cycle costs for consumers by up to 14% in case of replacement by the user, and 9% if conducted by a professional repairer. With a two-year extension, these savings could go up to 27% in case of a self-repair, representing a gain of 338€ over 4.5 years. According to the eco-design preparatory study of the European Commission[219], total customer expenditure per year could go down significantly with improved reparability (see Table 4).

[213] Makov et al. (2018)

[214] In addition, trade-offs between design for reparability and longevity should be taken into consideration. Studies found that products designed to be more resistant may see their reparability limited, and vice versa (Cordella et al, 2021b). Thus, while products might be designed to last longer or use less material, this might reduce their capacity for repair, remanufacturing and recycling. This factor could be further studied in relation with upcoming ecodesign regulation.

[215] Stahel (1994)

[216] European Parliament (2016)

[217] European Commission (2021)

[218] Federal Trade Commission (2021)

[219] European Commission (2021)

Table 4. Average Product Life Cycle costs per year (European Commission 2021)

	Low-end smartphone		Mid-range smartphone		High-end smartphone	
Baseline	85,44 €	100%	174,03 €	100%	296,27 €	100%
Ecodesign requirements allowing DIY repair	65,32 €	76%	129,25 €	74%	223,13 €	75%
Ecodesign requirements facilitating professional repair and increasing durability	67,41 €	79%	132,96 €	76%	234,02 €	79%

Overall, customers would benefit from eco-design measures since higher robustness, modularity (e.g. exchange of batteries), and better support for updates and repair tackles major lifetime limiting factors of their product[220].

4.2.2.1.2 Manufacturers

Implementing a systemic right to repair would also have a clear impact on the manufacturers of electronic devices. Compliance with stricter eco-design standards would bear on profit margins, as manufacturers grapple with the choice of increasing retail prices to make up for the lost revenue. Retailers and manufacturers could also face increased exposure to liability from guarantees or other kinds of extended producer responsibility. Spare parts availability might become a risk for OEMs as they have to ensure stock production and availability for a longer period of time.

Most importantly, increasing the rate of product repair and extending the calendar of product replacement would also bear on manufacturers' turnover[221]. In early 2018, after Apple was found to be slowing down certain models of iPhones in order to compensate for degrading batteries, the company reduced the price of out-of-warranty battery replacements for iPhone 6 and later models. The following year, Apple's CEO explained in a letter to investors that iPhone sales were lower than anticipated due to, among other things, "some customers taking advantage of significantly reduced pricing for iPhone battery replacements"[222].

Given that the bulk of production of electronic devices is done in third countries, imports of new products in the EU also has the potential to decrease. However, out of the 180 million mobile phones imported in the EU27 in 2018, only 2 million were produced in EU countries[223]. The economic impact of the decrease in imports would thus be largely felt outside the EU, predominantly in Asia and the U.S.

The Ecodesign preparatory study of the Commission (2021) warns that shrinking smartphone sales could have a slowdown effect on innovation on core technologies such as semiconductors, sensors, printed circuit board technologies, display technologies and mobile batteries. As a side effect, less semiconductor consumption would help ease the global crunch on semiconductor and *de facto* reduce the EU's dependency on Asia-based producers – creating some breathing room for the development of a semiconductor ecosystem in Europe, as encouraged by the EU Chips Act.

Nevertheless, the initial loss in turnover for manufacturers could be partially counterbalanced by the supply of spare parts to repair aftermarkets. For retailers, the design changes related to unbundled packaging would reduce logistics costs[224]. Finally, following the recent introduction of reparability index in France, increased reparability has the potential to become a selling argument and a competitive advantage. Future research could look into the effect of such measures on consumers purchasing patterns.

4.2.2.1.3 Impact on other industries

A Right to Repair would be enforceable by consumers and businesses alike. Companies benefit from a longer lifetime for products in the same way households can enjoy more of a product's utility, from a longer, better or more efficient use of capital stock, for instance. These benefits translate directly to an increase in value-added and therefore competitiveness[225].

[220] European Commission (2021)
[221] European Commission (2021)
[222] Cited in Federal Traded Commission (2021)
[223] Eurostat (2018)
[224] European Commission (2021)
[225] Lacy et al. (2014)

From a sector perspective, the introduction of a right to repair would have far-reaching positive effects for professional repair services (B2C and B2B), third party spare parts provision and provider or repair tools. Professional repair services are expected to benefit more, if repairs are simplified, but beyond the typical DIY level. Users are likely to consult professional repair shops more frequently, if spare parts availability is given and repair costs go down due to tool availability and repair-friendly designs[226]. SMEs and local repair shops be the biggest beneficiary of these changes[227]. Manufacturers and retailers would also benefit as they step into the domain of in-house repair services, while increased competition in the sector might lead to the development of new European leaders of repair services.

Knock-on effects would also take place in related sectors such as recycling. A more reparable design would simplify processes for recyclers, while not necessarily leading to more recycling[228]. Easier dismantling also allows for components harvesting, resulting in higher resale value than the recyclable materials contained in them.

4.2.3 Macroeconomic impacts at EU level

A right to repair implemented at European level would also have macroeconomic benefits in terms of competitiveness, trade balance and functioning of the EU internal market.

Policies aimed at a longer lifetime for products will result in increased standardization of repaired or refurbished goods and secondary raw materials. This is a common indicator for global competitiveness, which would imply that a longer lifetime would increase the attractiveness of EU goods[229]. Similarly, a harmonised legislative framework at EU level would increase cross-border services, which favours competition, attracts investments and increase the competitiveness of European business abroad. The European Union could also benefit from a first-mover advantage in creating the standards for a right to repair ecosystem (e.g. ecodesign rules), setting the ground for a new "Brussels Effect"[230] where European standards-setting triggers global regulatory convergence.

A simple way to express the competitiveness of the EU is to look at the trade balance. An increased in the value and lifetime of products would reduce the need for imports of new devices, as the stock lasts longer and is valorised by the marketplace[231] (European Parliament, 2016). Fewer imports would be required to maintain the current level of B2B and B2C stock in the European market, while creating more low-and-medium-skilled jobs within the EU. Another potential source of improvement in the European trade balance is likely to be realized by an increase in demand for more repairable EU products. Indeed, increasing standards can actually increase the manufacturers' value-added and profits[232]. If European manufacturing has to adhere to more stringent legislation on product lifetimes, an improvement in exports in the order of magnitude of several percentage points is within the range of reported results[233].

4.2.3.1 Community repair and social economy

4.2.3.1.1 Jobs creation

In general, the transition to a circular economy would create significant number of jobs. According to a study by British research groups, repair, reuse and recycling activities could create 1.2 million jobs in Europe[234]. An analysis of global sectoral economic data in 2011 reveals that just four material-intensive sectors (i.e. construction, food products, primary metals and non-metallic minerals and power generation and distribution) account for almost 90% of global material use, while relying on only 15% of the workforce. This suggests that overall job losses resulting from policies that tackle materials consumption might be modest. This loss could potentially be more than compensated by job creations in more labour intensive sectors, most notably services[235].

The benefits in terms of employment are very significant, because a metric ton of buried waste only creates the equivalent of one local full-time job, or three jobs if incinerated. In contrast, it can generate 30 jobs when

[226] European Commission (2021)
[227] Deloitte (2016)
[228] European Commission (2021)
[229] Tukker and Tischner (2006)
[230] Bradford (2020)
[231] European Parliament (2016)
[232] Lacourbe (2015)
[233] European Parliament (2016)
[234] Mitchell et al. (2015)
[235] Laubinger et al. (2020)

materials are sorted and recycled, and with reuse can provide full-time work for 85 to 130 people. With a right to repair, the loss of jobs due to smaller sales of digital devices would be offset by the creation of quality jobs in the repair sector. This would increase the demand for low-and-medium-skilled jobs and for people with vocational education[236]. Indeed, repair activities are usually conducted by SMEs or social enterprises and has one of the highest levels of labour intensity among circular activities. The sector thus has a lot of potential for jobs creation[237]. The positive effect of a right to repair in the economy would be spread geographically across the EU, since factors such as consumer trust, speed and convenience mean repair and maintenance are usually done locally. By contrast, the main losses in terms of jobs would be concentrated on manufacturers, which is in large majority outside of the EU.

4.2.3.1.2 Impact on underprivileged communities

Given the importance of social enterprises in the repair sector[238], jobs creation linked to a right to repair would also heavily benefit marginalized communities. According to the Federal Trade Commission report[239], the development of a right to repair would be a life-line to many black-owned small businesses in the repair and maintenance industries. In Europe too, the high share of immigrants in the repair sector shows that promoting repair can create opportunities for underprivileged groups. Access to affordable repair services and better quality second hand digital devices would ease the financial burden of technological equipment in low-income households[240]. Evidence show that lower-income Americans are more likely to be smartphone-dependent, and black and Hispanic Americans.[241]

4.2.3.1.3 Skills

Many studies predict an increase in demand for low- and medium-skilled jobs, related to policies aimed at a longer lifetime for products[242]. This positive impact could become a reality if the availability of low- and medium-skilled labour in the EU is combined with the required skills to increase the lifetime of a product[243]. There is a relatively low initial skills barriers to enter the repair business, which creates an opportunity for low-qualifications populations[244] as well as a potential to attract diverse background.

Moreover, a right to repair would have repercussions in research and development activities to meet the new technical requirements (e.g. eco-design and spare parts) as well as on education (creation of repair courses, training, awareness in primary and secondary school).

4.2.4 Geopolitical benefits and risks

From a geopolitical perspective, the right to repair and circularity does not only become an opportunity but a necessity. Rare earth minerals for electronic products are mined in only few countries and "*growing geopolitical tensions and trade wars are threatening the security of supply for major rare earth minerals that are integral to electronics*"[245]. Increasing the lifespan of products through repair thus also decreases the amount of raw materials to produce new phones and eases the pressure on raw material mining and import. At the same time a focus on circularity and repair allows to better make use of the available resources in Europe, especially of older electronic equipment, that could easily be repaired and reused but might be stored in homes unused. The potential of these urban mines has received increased attention in recent years. It is estimated that in the EU there are 1.8 million tonnes of electric equipment stored in homes, translating to 250kg of electronic products per EU citizen. Better use of these existing products through repair or recycling could reduce the EU's dependency on third countries.[246]

Especially worrisome is the global chips shortage and the increasing geopolitical importance of semi-conductors, as the backbone for consumer electronics and digital societies.[247] By extending the lifetime of products and opting for repair and refurbishing of products, these critical components can remain longer in use and dependence on other countries can be reduced.

[236] European Parliament (2019)
[237] Llorente-González (2020)
[238] ADEME (2018)
[239] Federal Trade Commission (2021)
[240] Federal Trade Commission (2021)
[241] Povich (2021)
[242] E.g. TNO (2013); European Commission (2014)
[243] European Parliament (2016)
[244] Türkeli et al. (2019)
[245] BSR Sustainable Futures Lab (2022)
[246] ProSUM (2022)
[247] Csernatoni (2021)

A study by Deloitte (2016) found that increased reparability and durability could reduce the dependence on imports. On the other hand, it could increase the import of spare parts, but overall the balance is "expected to be positive"[248] and the dependency to be lower.

While reduced import of products and raw materials might have an impact on trade and trade businesses, this could be offset by the additional jobs created within the Union for repair businesses and recycling. A secondary market for repaired and refurbished electronic goods could well extend beyond the EU and could strengthen trade relations with neighbouring countries.

In addition, better waste management and repair of products, will decrease incentives for (illegal) waste shipments abroad.[249]

While out of the scope of this study, further research might be needed to look into competition law and international trade agreements to look at potential limitations to the right of repair when it comes to Intellectual Property Rights agreed on in international agreements.

[248] Deloitte (2016)
[249] Taylor (2021)

5 Recommendations

5.1 Overview of measures supporting the repair of electronic devices

As a first step, measures can be taken to **increase the durability** of devices, thereby not only reducing the need for repair, but also improving the reliability of refurbished devices and longevity of components for a potential second life as spare parts[250]. It would encourage customers to repair, expecting their device to continue working properly for a significant period afterwards. Such measures can include stricter rules to prevent planned obsolescence of products and associated software, such as requirements for the availability of software updates for a given period, information on updates and consequences (e.g. the law REEN[251]).

A logical next step would be to match guarantees with new durability requirements for products[252]. Lengthening the minimum time of manufacturing guarantees would also encourage manufacturers to to offer a commitment to repair and to design their product for longevity, for instance to increase resistance to accidental drops and its protection from water and dust[253]. Consumers have high trust in these guarantees, more likely to seek repair if covered by guarantee[254].

Reparability must be included in the production of electronic devices. Measures could introduce **eco-design**[255] not only for longer product-life but also to ensure easier repair. Certain design practices hindering or preventing repair described in the barriers section should be restricted to foster repair-friendly design practices such as design-for-disassembly and modular design concepts (which would also enable hardware and aesthetic upgrades). Substituting hazardous substances by safer substances, wherever technically possible, is covered by the Directive on the Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS)[256]. Investing in research and innovation is also a key enabler. Eco-design requirements could take advantage of digitalization also facilitating access to repair data and information.[257]

The work programme 2021-22 of Horizon Europe includes 4 different calls[258] with expected outcome in terms of repair strategies, support solutions and innovative digital tools for repair and refurbishing, sensing devices and components allowing high levels of reuse/repair/repurpose.

Once the design of the device allows repair, customers and repairers must be empowered to perform it. The eco-design directive[259] required the availability of **spare parts** for defined period to independent repairers, refurbishers and individual consumers for other products. Similar measures could apply to improve the access to the necessary diagnostic and repair **tools**. Standardisation of some components would allow interchangeability and interoperability, and thereby limit the variety of components and tools needed. It is for instance the aim of the Common Charger Initiative. The aim of the Common Charger Initiative[260].

To be empowered, customers must also be properly and systematically informed. Providing **information on the reparability** of products can encourage consumers to choose products that are easier to repair[261], and it turn push Original equipment manufacturers (OEMs) to facilitate repair[262]. Several existing labels[263] take into account reparability criteria for digital devices (e.g. availability of spare parts and information), such as the Blue Angel ecolabel in Germany for smartphones. iFixit, an online platform providing repair guides, has developed its Reparability Score, benefiting from support under a Horizon 2020 project[264]. The Joint Research

[250] Cordella et al. (2021b)
[251] LOI n° 2021-1485 du 15 novembre 2021
[252] Terryn (2019)
[253] Cordella et al. (2021)
[254] European Commission (2018)
[255] Dalhammar et al. (2016); Milios (2018); Stahel, 2019; Vence and Pereira, 2019
[256] Directive 2011/65/EU; Regulation 2006/1907/EC
[257] Hedberg et al. (2020)
[258] HORIZON-CL4-2021-TWIN-TRANSITION-01-02: Zero-defect manufacturing towards zero-waste (Made in Europe Partnership) (IA) HORIZON-CL4-2022-TWIN-TRANSITION-01-07: Digital tools to support the engineering of a Circular Economy (Made in Europe Partnership) (RIA)
HORIZON-CL4-2022-DIGITAL-EMERGING-01-03: Advanced multi-sensing systems (Photonics Partnership) (RIA)
HORIZON-CL4-2021-SPACE-01-21: Reusability for European strategic space launchers - technologies and operation maturation including flight test demonstration
[259] Directive 2009/125/EC
[260] https://ec.europa.eu/commission/presscorner/detail/en/IP_21_4613
[261] European Commission (2018); European Commission (2021b)
[262] Metro (2021)
[263] European Commission (2021)
[264] https://www.sustainably-smart.eu/

Center (JRC) has developed a methodology for a reparability scoring system[265]. France has introduced a reparability index in application since 2021[266] thereby creating a precedent. While the European Commission explored options for horizontal requirements on the provision of product reparability information under the Circular Economy Strategy, a scoring on reparability does not however appear to be currently considered in relation to the energy labelling of mobile phones and tablets[267]. The obligation to indicate the lifespan of a product and an indication of whether a company would cover defects during this lifespan was also suggested by a report from the European Parliament[268]. Such common European reparability index would indeed be a strong incentive both for businesses to focus on enhancing the lifespan of a product in their design phase, and for customers to choose the most sustainable purchase[269].

Legislation could also make compulsory the inclusion of **repair instructions** for minor defects in user manuals[270], and inform of the procedure to address more significant repairs. A policy option under Sustainable Products Initiative Inception Impact Assessment proposes to establish EU rules for setting requirements on mandatory sustainability labelling and/or disclosure of information to market actors along value chains in the form of a digital product passport[271]. Consumers could indeed use digitally-enabled solutions like QR codes, apps or online platforms to verify claims and access other relevant information on correct use, maintenance, repair, disposal and recycling products[272].

While the right to repair is fragmented in Europe, a common multilingual EU-repair platform could be funded as a one-stop-shop or information repository on electronics repair. It could include reparability labels, repair initiatives, information on European/national repair rights and redress mechanisms put in place.

To increase the competitiveness of repair, measures could also **reduce incentives to buy** new phones. They could consist in limitations of phone subsidies by telecom operators[273], or payment of phones on credit as monthly subscription costs, perceived as more affordable, tends to increase substitution frequency[274]. Retailers could also have the obligation to inform consumers of **refurbished offers**.

Being a large consumer of electronic devices, public authorities have the ability to significantly affect the market. **Green public procurement** (GPP) setting of targets for public purchasing of environmentally friendly/repairable products (goods with reparability index above a certain threshold) is an efficient instrument for upscaling and mainstreaming. Public authorities can thereby support transition towards a resource efficient economy as an on-going service relationship and contribute to the devices' lifetime extension[275]. The European Commission has developed comprehensive guidance for GPP and it encourages Member States to develop National Action Plans for it. Many Member States have gone beyond the EU guidance and have specific legislation and regulation in place to include environmental and social sustainability criteria[276]. This includes some criteria for mobile phones related to reparability (e.g. availability of replacement battery for 5 years).

Efforts should focus as well on **education and awareness raising** regarding environmental impact of digital tools, the benefits of repair, and customers' legal rights to repair[277]. It would contribute to increasing the saliency of circular electronics characteristics and trigger shifts in preferences towards more durable/repairable products[278]. Measures could include raising the topic for young people in schools, add eco-design of digital services as a part of the engineering training[279].

Other **behavioural incentives** can be explored to nudge customers towards choosing repair, such as gamification approaches to integrate circular economy into daily life of residents (e.g. in Antwerp[280]) or altering social norms by linking the idea of easily reparable with 'high quality' and 'cost-savings'.

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[265] Cordella et al. (2019).
[266] https://www.indicereparabilite.fr/
[267] European Commission (2020)
[268] European Parliament (2017)
[269] Milestone for *Flagship for a resource efficient Europe*, European Commission, 2011
[270] European Commission (2018)
[271] Sustainable_products_initiative_(europa.eu)
[272] Hedberg et al. (2020)
[273] LOI n° 2021-1485 du 15 novembre 2021
[274] Boons & Lüdeke-Freund, 2013
[275] Riisgaard et al. (2016)
[276] https://ec.europa.eu/environment/gpp/index_en.htm (2021)
[277] LOI n° 2021-1485 du 15 novembre 2021
[278] European Commission (2018)
[279] LOI n° 2021-1485 du 15 novembre 2021
[280] https://www.antwerpen.be/info/5a03128bca69bccdc216d7bb/antwerpen-wordt-proeftuin-voor-circulaire-economie-met-circular-south

Cities and regions too have a major role to play in building local ecosystems centered on **waste reuse and management**. The goal is to revise production processes and move away from nonselective massive waste collection and processing, toward selective upstream collection so that everything repairable is separated from everything that is not. New methods are needed to structure these emerging sectors and ecosystems, including a focus on partnerships with districts and cities. The structure could include initial sorting points at waste collection centers, and transport recoverable goods to reuse points where they are sorted more methodically and then dispatched to the different schemes.

Given the diverse natures of barriers preventing or limiting the reparation of digital devices, addressing the issue holistically requires a mix of policies. Such policies must be part of a multi-faceted approach supporting the transition to a circular economy[281] and be firmly anchored in the broader circular economy action plan and circular electronics initiative. This report will however focus on developing more detailed recommendations for measures addressing legal barriers preventing repair and measures supporting the supply of repair services. The recommendations were classified either as options when they correspond to policy alternatives, or as actions when they are not mutually exclusive and can be implemented in combination. For each action or option, the degree of ambition is indicated.

5.2 Addressing intellectual property barriers preventing repair

When analysing barriers, risk and opportunities for the right to repair in connection to IP rights, two main recommendations were found to make repairs easier.

5.2.1 Recommendation 1: Make repair possible

Rationale: One of the key issues around IP rights is the lack of harmonization in the EU (see barriers Chapter 4.1). This is due to the facultative nature of the list of possible copyright exceptions included in the Copyright Directive of 2001[282]. The relevant exception for a right to repair is Article 5.3.l of the Directive, which provides a copyright exception for "use in connection with the demonstration of repair of equipment". However, only a few Member States have adopted this exception (Germany, Poland, Czechia and Austria).

As there is currently no all encompassing right to repair, individual exceptions are needed to make repair possible.

Examples of existing measures: Exemptions for the purpose of repair can be found in the 2001 Copyright Directive.

Actions at EU level: A more ambitious Right to Repair framework linked to eco-design criteria for enhanced reparability and a more harmonious set of rules across all member states is needed.

Box 2. Make repair possible - Option 1 (ambitious)

Create a Right to Repair that allows for an exemption on all IP rights with regard to repairs and reselling of products.

The Right to Repair starts with design for reparability and durability. Every repairer will have the right to access repair manuals, spare parts can be sold by individual manufacturers and will be available at a reasonable price. In exchange, liabilities after repair lie with the repairer if the OM provided all needed documentation on the product and the repair, if the default can be linked to the repair process.

[281] Wilts et al. (2019)
[282] Directive (EC) No 29/2001

Box 3. Make repair possible - Option 2 (moderate)

Introduce a broad exemption for repairs within the "fair use exemption" ensuring existing exemptions are not used against allowing repair.

A more moderate revision option would be a **broad exemption for repair activities**. This would avoid labour-intensive additions of exemptions in future revisions. It would encompass existing but also currently non-existent or unforeseen uses and contexts. This approach, known as a "fair use exception" has the benefit to be flexible and technology-neutral, and is currently used in some states of the United States. Fairness factors include (i) the purpose and character of the use; (ii) the nature of the copyright material; (iii) effect of the use on the potential market/value of the copyright material and (iv) the amount and substantiality of the part used. However, this option has historically been opposed by the European industry.

Box 4. Make repair possible – Option 3 (basic)

Make current facultative exemptions on Copyright mandatory to harmonize repair rights across the EU.

A recommendation to enable a right to repair at EU level would be to **make the Article 5.3 exception of the 2001 Copyright Directive mandatory** to harmonise current legislation in Member States. Moreover, to allow the publication of repair manuals, EU legislators could introduce a specific exception for the reproduction and sharing of information for the purpose of repair, also known as a **"fair dealing exception"**. It would provide greater certainty to independent repairers and allow lawmakers to explicitly state the circumstances under which third parties may (or may not) use and share copyright information for the purposes of repair.

5.2.2 Recommendation 2: Prohibiting digital locks and contractual limitations to the right to repair

Rationale: Manufacturers of digital devices heavily rely on technical protection measures (e.g. "digital locks") which cannot be circumvented under existing EU directives. While the 1991 Directive on the legal protection of computer programs allows a copyright exception when correcting errors in the program, this exception is restrictive and cannot be used to improve/upgrade the device. Moreover, it would only apply to software repairs (or "debugging"), leaving out the situation a right to repair would strive to address: the impossibility of a hardware repair due to a software lock.

Another manufacturer-imposed restriction to product repair is often contained in End User Licence Agreements (EULAs). These contractual clauses, agreed to by the consumer when they use a software-powered product (e.g. a smartphone), allow the manufacturer to void the warranty if the user repairs the products outside of the manufacturer-sponsored circuits. This also opens independent repairers and self-repairers to potential law suits for breach of contract or to warranty loss – both strong deterrent to exercising a right to repair.

Examples of existing measures: No existing measures.

Actions at EU level:

Box 5. Prohibiting digital locks – Option 1 (ambitious)

In the scenario when a **general right to repair** is granted to consumers and businesses, the EU could make it unlawful for digital locks or End User License Agreement (EULAs) to restrict it. This option is particularly ambitious as it involves harmonizing a single exception throughout the national contract and IP laws of Member States.

In essence, as argued by Svensson et al (2021), this entails a clarification of the boundary and balance between intellectual property rights and repair rights (i.e. exceptions to intellectual property rights and recognition of other rights to be balanced with these). It also implies the protection of consumer rights against sellers or license-holders with superior bargaining power.

Box 6. Prohibiting digital locks – Option 2 (basic)
Create a ***restrictive* general copyright exemption for circumventing digital locks**, being enforceable both by consumers owning the device and by third party repairers on behalf of the owner. It would be a restrictive exemption, whereby repairs could only address pre-existing issues using certified parts from the manufacturers.

5.3 Supporting the competitiveness and up-scaling of the repair supply sector

5.3.1 Recommendation 3: Economic incentives for repair

Rationale: By reducing the relative cost of repairing electronic devices compared to purchasing new products, financial incentives can make it a more competitive option. Considering that the cost of repair is a key obstacle to repair (see section 4.1.2.), such measures have the potential to increase the demand for repair, creating market opportunities for repair businesses[283]. By lowering the price effectively paid by consumers, such measures could also allow repairers to increase their prices, reinforcing the sustainability of their business models, which is affected by high costs limiting their profitability[284] (see section 4.1.2.). The actual effects of financial incentives on the demand of repair services depends on the extent to which this demand is determined by prices, and the extent to which repairers would increase their prices in reaction. From an economic perspective, financial incentives are justified by the positive externalities of repairing electronic devices (e.g. reduced environmental footprint), which are not directly reflected in the price or repair services[285].

Examples of existing measures and empirical evidence: Financial incentives for repair are in place in different EU Member States, under diverse forms.

- **Reduced value added tax (VAT) rates on repair services.** The EU VAT Directive[286] allows the application of reduced rates (minimum 5%, instead of minimum 15%) for certain repairs (bicycles, shoes, textiles), but not electronic devices. Belgium, the Netherlands and Sweden are applying such reduced rates.
- **Repair subsidies.** In 2016, the city of Graz, in Austria, implemented a 50% subsidy on the repair of electric devices, with a €100 ceiling per household/year. In practice, citizens of Graz can apply for a partial reimbursement after a repair service. Following this example, Styria, Lower Austria, Salzburg, Upper Austria and most recently Vienna introduced similar systems, as well as Thuringia in Germany. Starting in 2022, all Austrians are to receive up to 200 euros for the repair of electrical and electronic equipment, financed by the Covid-19 recovery fund[287]. Another model, applied in Sweden for repair of household appliance, is making repair costs deductible from income tax[288]. The proposed REEN Law in France would have allowed tax reductions for SMEs of up to 50% of expenses for purchasing reused or refurbished products, but this measure was not adopted.
- **Tax-free payment means.** In Belgium, the "écochèques" are a payment scheme proposed by employers and exempted from tax. They can be used for purchasing repair services, notably of electronic and IT devices, but this represents less than 5% of spending, while the purchase of new appliance (with high energy performance scores) remains the most common spending.
- **Repair fund financed by eco-contribution:** in 2020, a law adopted in France established a repair fund[289] to reduce the price of repair (outside of legal warranty), including for electric and electronic equipment (EEE)[290]. The fund allows consumers to benefit from a reduction of the price of repair when purchasing the service, which is then reimbursed to repairers. To benefit from the fund, beneficiaries must be part of a certified network of repairers and respect certain conditions. The fund

[283] European Commission (2018)
[284] ADEME (2018)
[285] Milne et al. (2012)
[286] Directive 2006/112/EC
[287] Right to Repair Europe (2021)
[288] ADEME (2018)
[289] LOI n° 2020-105 du 10 février 2020
[290] Halte à l'obsolescence programmée (2021)

is financed by eco-contributions[291] under the extended producer responsibility scheme. The practical modalities are defined by each sector. In 2021, the EEE sector adopted modalities that were criticized as lacking ambition.[292]

Demands for repair subsidies in Austria and Germany are rapidly increasing[293], but assessing to what extent they correspond to a rise in the demand for repair or to deadweight effects would require further research. Research on reduced VAT on small repair and tax reliefs in Sweden did not find significant effects on the demand for repair, due notably to their narrow scope and lack of accompanying policies[294]. The effects of reduced VAT rates on all repairs, or of repair subsidies are more significant, but still moderate[295]. Reduced VAT rates do not represent a major price reduction, which may limit their impact on repair decisions[296]. They however affect more consumers, as they apply at the moment of purchase, and represent a much lower administrative burden than subsidies. Reduced VAT is more progressive than income tax breaks[297]. VAT indeed tends to disproportionately affect low-income households, who would thus benefit from lower VAT rates. Income tax breaks, by contrast, would only benefit households that earn enough income to pay such taxes. All tax incentives would lead to a reduction of tax revenue, especially a reduced VAT rate on all repairs, but would also generate positive indirect tax revenue due to increased activity and spending[298]. Reduced VAT rates are unlikely to have negative effects on the functioning of the internal market as the relevant products and services are generally not traded across EU borders[299].

Actions at EU level: (Note: actions are not mutually exclusive and could be implemented in combination)

Box 7. Introduce differentiated VAT rates according to the degree of circularity – Action 1 (ambitious)

By restricting the application of reduced VAT rates for repairs only to certain products, the EU VAT Directive currently prevents lowering VAT rates on electronics repair. The proposed revision of the directive, by turning the list of goods and services that can benefit from reduced rates into a negative list of products that cannot (which would not include repair services), would partly address this issue[300]. However, the Council agreement on the updated rules for VAT rates[301] of 7 December 2021 re-introduced a positive list, which does not include repair of electronics.

An innovative and ambitious approach, which could be considered for a future revision of the Directive, would consist of using differentiated VAT rates according to the degree of circularity. Such classification could be based on the waste hierarchy. Products and services related to waste prevention, including repair services and the purchase of re-used products, could benefit from a reduced VAT rate or a VAT exemption. By contrast, higher rates would apply to single-use or resource-intensive products. To avoid limiting improvements in energy efficiency, such differentiated rates could apply only on products with a footprint resulting mostly from the manufacturing phase, like digital devices. A clear classification of activities would be required to avoid loopholes.

To be impactful, these differentiated VAT rates would need to have a broad scope[302]. They would need to be applied in combination with other policy tools, for example schemes to certify the quality of repairers (as applied in Graz and in France with the repair fund, see recommendation 2.4), tools to find repair services or communication measures. VAT measures should be considered as part of a broader taxation framework supporting the transition to a circular economy, which could include a natural raw material resource tax and a waste hierarchy tax at the end of life of products[303].

[291] In France, the cost associated to the collection, treatment and recycling of certain products under the extended producer responsibility principle is called the éco-contribution. This additional cost, for products like electronic devices, needs to be distinguished and visible by the consumer.

[292] With only 10% of reimbursement instead of the 20% planned by the implementing decree, and a very progressive implementation until 2027. Zero Waste France (2021)

[293] The number of applications for subsidies in Graz has increased from 163 in 2017 to 2956 in 2019. (Lechner et al. 2021)

[294] Dalhammar et al. (2021)

[295] Köppl et al. (2019)

[296] Laitala et al. (2021)

[297] Köppl et al. (2019)

[298] Köppl et al.

[299] Copenhagen Economic (2007)

[300] COM/2018/020 final

[301] Council of the European Union, 14754/21

[302] Köppl et al. 2019

[303] Milios (2021)

Box 8. Encourage Member States to introduce economic incentives – Action 2 (basic)

A more feasible approach, considering the difficulty of adopting common EU rules related to taxation, would consist of encouraging Member States to introduce financial incentives targeting final consumers for supporting reuse and repair.

The European Commission could support such developments by providing guidance, for example through a toolbox for Member States (e.g. taking the form of a Communication) proposing measures that are compliant with EU law. Such recommendations could include promoting the use of NextGenerationEU funding to finance repair incentives, as is currently done in Austria. This toolbox would complement the Circular Economy Action Plan[304], which identifies economic instruments, such as environmental taxation (including waste taxes) and VAT rates as potential means to promote circular activities that target final consumers. The Commission could also use existing frameworks, like the European Semester or the review of national recovery plans, to promote such instruments. The Commission could develop guidelines on how to promote repair in relation to the extended producer responsibility scheme. The revision of the EU Directive on waste[305] indeed allows more use of effective economic incentives in support of waste prevention.

The Commission could also establish a platform (e.g. expert group) to allow a dialogue and exchange of experience and good practices between Members States, as well as local governments (regional, urban)[306]. Such a platform could for example allow the sharing of best practices on how to combine other policies with financial incentives.

5.3.2 Recommendation 4: Support the availability of a skilled workforce for repair

Rationale: The sources of employment that have disappeared from the repair sector need to be restored, and access to the required skills is essential to perform repair services. As described in section 1.2.4., the constant evolution of digital devices requires continuous training. The lack of attractiveness of repair jobs[307] can limit the development of repair supply, even if demand increases. A mismatch between the skills of unemployed people and available jobs is a driver for unemployment in the EU. Several sectors are likely to suffer from employment reductions as a result from the green and digital transitions. The development of the repair sector therefore creates opportunities for re-skilling and up-skilling. Besides, these are jobs that cannot be relocated, and being geographically closer to day-to-day uses makes it an economic activity with deeper local roots. Measures promoting training and education activities increasing workers' technical skills in the domain of electronic devices repair, but also the required entrepreneurial and social skills, would help both address barriers to the supply of [308] and multiply local job opportunities. Supporting skills related to innovative technologies like 3D printing can help develop and mainstream new solutions facilitating repair[309]. This should be complemented by actions promoting the interest of working in the repair sector, notably to young people, and to ensure that these jobs offer good working conditions. It is also important that engineers and designers, notably working on digital devices, have the will and appropriate skills to adopt eco-design practices and consider the environmental impacts. Finally, fighting gender stereotypes affecting career choices is essential. While certain repair-related activities, such as (unpaid) repair of clothing, may be perceived as more feminine, women are often underrepresented in manual activities and professions linked to engineering and technologies. In addition to creating inequalities, this limits the availability of skilled workforce.

Examples of existing measures:

- The recently adopted REEN Law in France provides that training including awareness-raising on the impact of digital tools and digital sobriety must be established already from school[310]. It also requires that any training of engineers includes a training module on eco-design of digital services and digital sobriety[311].

[304] COM(2020) 98 final
[305] Directive 2018/851/EU
[306] Hedberg et al. (2020)
[307] Laitala et al. (2021); Deloitte (2016)
[308] Whalen et al. (2018)
[309] https://www.nweurope.eu/projects/project-search/sharepair-digital-support-infrastructure-for-citizens-in-the-repair-economy/events-and-activities/3d-printing-for-repair-masterclass/
[310] LOI n° 2021-1485 du 15 novembre 2021, Article 1
[311] LOI n° 2021-1485 du 15 novembre 2021, Article 3

- Grassroots initiatives like Repair Cafés have a key role in developing repair skills, for example by organising events where professionals and non-professionals freely offer their knowledge and competences.
- An interesting project is Girls Go Circular, managed by the European Institute of Innovation and Technology (EIT), aims to support schoolgirls and students in general, to develop their digital and leadership skills while learning about the circular economy[312]. Supporting the repair of smartphones is one of the challenges it explicitly targets.
- The Federation Envie's core mission is rooted in a project focused on finding smart opportunities for creating employment integration posts. It started in 1984 in Strasbourg with a meeting between a social worker from Emmaüs and a senior manager at electrical retailer Darty. They set out a plan to employ young people from disadvantaged districts to repair electrical and electronic products. It also aims to help people excluded from the workforce to find possible points of entry. After staff have worked at the company on an integration contract that can last up to two years, they help them find long-term employment.
- In Belgium, the social economy sector gets a premium for the training and employment of people who are far from the regular labour market. Benefit from reinsertion allocation + subsidies. E.G. For workers without diploma, unemployed, over 45. Companies need to be recognised as "entreprises d'insertion"

Actions at EU level: The competences of the EU in education and vocational training are limited to supporting, coordinating and supplementing the actions of Member States[313]. The European Commission could however build on the different EU programmes supporting upskilling and reskilling (see table 5) and build on existing platforms. In the context of the Pact for Skills, a roundtable was organised on Proximity and Social Economy Ecosystem[314], recommending the development of green skills, notably in relation to electronics and the circular economy, and will be followed by workshops with experts. The European Circular Economy Stakeholder Platform[315] also offers a toolbox related to education and skills. Finally, when monitoring the progress of the Circular economy, the EU should also monitor socioeconomic impacts (profiles, wages, length and intensity of workdays, type and duration, access to social security and union representation, etc.). [316] The actions presented below are not mutually exclusive and could be implemented in combination.

Box 9. Skilled workforce – Action 1 (ambitious)

To complement the current efforts in upskilling and reskilling, **'technology classes'** could be deployed in schools all around the EU teaching basic understanding of how certain everyday life objects (such as out phones) work, which can be seen as obscure black box. Such classes would build the background knowledge and potentially also elementary repair skills to interest and confidence. They could also teach about environmental and social impacts to raise awareness and build sensitivity to these matters. Mandatory courses on circularity and eco-design in engineering studies would be complementary and equally important, to mainstream the vision and skills across the industry. This measure is recognised as very ambitious, considering the limited competency of the EU in the area.

[312] https://eit-girlsgocircular.eu/about/
[313] Treaty on the Functioning of the European Union, Article 6.
[314] European Commission (2020b)
[315] https://circulareconomy.europa.eu/platform/en
[316] Llorente-Gonzalez et al. (2020)

Box 10. Skilled workforce – Action 2 (ambitious)

Tax wedge cuts could be allowed for repair jobs in particular instances:

(a) reduced tax wedge for the first recruitments,

(b) reduced taxes on recruitment of employees that are far away from the labour market (e.g. long-term unemployment, no qualification), by certified social insertion enterprises (as is currently done in a number of EU countries).

For euro area Member States, the tax burden on labour, as measured by the tax wedge[317] is among the highest in the world. However, high tax burden on labour also corresponds to high degree of social protection and public service. Such measure should therefore be balanced and targeted. Reducing the tax burden on labour has the potential to support consumption, stimulate labour supply and create work incentives for low-income earners, as well as to improve repair companies' profitability and cost competitiveness. It should therefore increase demand, growth and support job creation. Such measure, which could be complementary to Action 1, is also very ambitious as again not depending on EU competency.

Box 11. Skilled workforce – Action 3 (moderate)

The EU could **boost the repair dimension** to all its relevant reskilling and upskilling initiatives. Training could be proposed at different levels, from high school to higher education and adult education. Such effort at EU level should be promoted via inclusive communication campaigns for circular jobs[318].

Box 12. Skilled workforce – Action 4 (basic)

DG EAC could organise a **'European eco-design competition'** offering classes (at different levels) or individual students the opportunity to work on re-designing an object in a circular manner. The award could be financial and/or involve participation in an EIT accelerator (communication action, skills development on a voluntary basis, awareness raising). It would also have the advantage of boosting pro-environmental attitudes.

Table 5 Programmes supporting upskilling and reskilling[319]

Programme	Accessible through	Scope in relation to digital device repair skills
InvestEU	Financial intermediaries	The Social investment and skills window (SISW) covers both the demand and supply of skills. Support targets students and learners, SMEs, mid-caps and providers of training.
EFSI 2 Skills and Education Guarantee Pilot	Financial intermediaries	Debt financing initiative to stimulate investments in education, training and skills. Final beneficiaries include students and learners, SMEs, mid-caps and training providers.
Recovery and Resilience Facility (RRF)	National authorities	Development of skills to support green and digital transition and resilience
European Social Fund Plus (under shared management)	National authorities	Providing flexible upskilling and reskilling opportunities for all. Anticipating new skills requirements based on labour market needs.
European Regional Development Fund (ERDF)	National authorities	Development of skills supporting industrial transformation and smart specialisations.
Just Transition Fund (JTF)	National authorities	Development of skills focused on reskilling of workers in regions affected by economic and

[317] The tax wedge is defined as the sum of personal income taxes and employee and employer social security contributions net of family allowances, expressed as a percentage of total labour costs (the sum of the gross wage and social security contributions paid by the employer).

[318] Repair & Share (2021)

[319] https://ec.europa.eu/social/main.jsp?catId=1530&langId=en

		environmental transition
Erasmus+	National authorities	Learning mobility of learners and staff; Strategic partnerships working on solutions supporting upskilling and reskilling; cooperation models with SMEs to support upskilling and reskilling; Blueprints for Sectoral Cooperation Centres of Vocational Excellence.
ESF+ EaSI Strand	European Commission	Support for innovative approaches in the field of upskilling and reskilling
European Globalisation Adjustment Fund (EGF)	European Commission	Upskilling and reskilling of workers at risk of losing their job due to globalisation, as a result of a restructuring event at local level

5.4 Recommendation 5: reinforce the trust of consumers in the quality of repair services

Rationale: Beyond lack of trust, uncertainty of how long the device will last after repair, according to a study for the European Commission[320], although most people were happy with professional repair services, 20% of consumers who had used repair services, a significant share, reported the quality of repair to be below expectations. There is clear evidence in the literature that improved service quality can contribute to increasing demand and customer loyalty[321]. Measures to ensure the quality of repair services and/or reused devices can thus help promote more circular practices.

Examples of existing measures and empirical evidence:

- One measure is to develop standards for testing repaired phones[322]. For example, the British Department of Business, Innovation and Skills developed the PAS 141:2011 protocol for mobile phones (WRAP, 2012), to ensure that the phone has been properly repaired and tested and functions correctly.
- Mandatory technical controls on refurbished products were considered in France in the context of the REEN law but were not included.
- In addition to legal requirements, networks of repairers can ensure quality standards. One example can be found in the Austrian city of Graz where members of the Graz repariert network must comply with quality standard (e.g. full cost transparency, mandatory consumer feedback scheme). Customers can give feedback on the service, which is collected by the organizers of the network. Failing to meet quality standards can lead to warnings and even disqualification of members, while meeting them allows repairers to obtain and display a quality certificate.

There is evidence in the literature, notably for IT goods, that a quality labelling scheme can boost consumer confidence in repairs[323].

Actions at EU level: (Note: The actions presented below are not mutually exclusive and could be implemented in combination.)

Box 13. Consumer trust – Action 1 (ambitious)

A European certificate for repairers granting a quality service label following third-party evaluation by a conformity assessment body against a set of common European standards. Certification among workshops could lead to an increase in the number of repairs since customers will know that the repair is of high quality.

[320] European Commission (2018)
[321] Lechner et al. (2021); McCollough (2010)
[322] Riisgaard et al. (2016)
[323] Gåvertsson et al. (2020)

Box 14. Consumer trust – Action 2 (moderate)
The European Commission could request the development of European standards (building on existing standards) to ensure proper testing of repaired and reused products. The Commission could also require the use of such standards in contracts with providers responding to tenders (i.e. repair companies or second-hand retailers) and encourage member states to do so, too.

Box 15. Consumer trust – Action 3 (moderate)
Making durability and reparability information available. Durability and reparability information is lacking and the provision of such information might potentially influence repair decisions due to doubt on the repaired product lifespan. Therefore, the following options could be explored:

- Integrate durability and reparability information into existing (EU) labels;
- Examine the development of a scoring system for reparability of products;
- Provide information to consumers on the availability of spare parts and repair services.

The provision of information not only needs to be presented in a way that consumers can understand and effectively use in their decision-making, but it also needs to be accurate. To ensure the accurate provision of information to consumers at the point of sale, continued and strengthened enforcement of national consumer laws (such as on unfair commercial practices) is of great importance to support consumers in their choices surrounding engagement in the Circular Economy.

Box 16. Consumer trust – Action 4 (basic)
The Commission could support the development of repairer networks ensuring quality standards (see recommendation 6).

5.5 Recommendation 6: reinforce the structuring of the repair sector

Rationale: As shown in section 1.2.3, the repair sector is highly fragmented, particularly for independent repairers. In many EU countries, the independent mobile phone sector is poorly organised[324]. This situation can make it more difficult for consumers to find trustworthy repair services. It also makes it harder for repairers to argue their case to national and urban-level policy makers, especially by comparison to large OEMs.[325] Organising and structuring the repair sector around federations grouping repairers could thus be a useful lever[326]. It can help create global dynamics and support initiatives related to training or communication. The membership in networks could help repairer improve quality and reduce costs, for instance by exchanging know-hows and repair or jointly acquiring spare parts[327].

Examples of existing measures and empirical evidence: [328].

- At national level, the UNETO-VNI federation in the Netherlands is active on aspects related to repair and warranties. It developed a label and a platform allowing members to exchange business and legal information on the repair sector.
- At local level, the Graz repariert[329] network is a repair network in Graz, based on a collaboration between the city administration and local repairers. Its main tasks include verifying quality standards among its members and raising awareness, notably through a common brand. It is linked to the local funding scheme for repair services (see recommendation 2.1).
- In France, the federation Envie[330] allows local organizations to retain their autonomy and run their repair, reuse and logistics activities in their specific area, while providing network support for communication, management tools and advocacy. It can also help set up systems in areas with no geographical coverage and provide support for existing installations with specific needs.

[324] Türkeli et al. (2019)
[325] Türkeli et al. (2019)
[326] ADEME (2018)
[327] Whalen et al. (2018); Sabbaghi et al. (2017)
[328] ADEME (2018)
[329] https://grazrepariert.at/
[330] Notre mission - Réseau ENVIE

- Also in France, the repair fund (see recommendation 2.1), in addition to allowing reductions of the price of repair services, aims to structure and make more visible the repair sector by creating a network of certified repairers, with shared resources such as tools for online diagnostics.
- The SHAREPAIR project[331] offers digital tools to facilitate citizen repair, targeting both consumers and more skilled repairers in repair cafés. Such tools will also map and guide citizens to high-quality professional repair services, and assemble, with the help of designers, a database of open-source 3D-printing designs for printing replacement part. It is notably working on a dataspace for repair[332], helping to pool and share repair data from different sources while minimising efforts for integration. To do so, it is building on data from the Open Repair Alliance[333], a federation of citizen repair organisations.

A study[334] on the Graz repariert network shows that it helped increase the visibility of repair businesses and attract some new customers. A key benefit for members is the opportunity for collaboration. As the network is not limited to a specific sector, repairers with different specialties (e.g. computers, mobile phones) can forward each other's products to repair or recommend other members to customers. 40% of members reported exchanging experience. The link with the funding scheme is an asset, with a possible effect on the number of applications. The brand recognition remains limited, possibly due to the narrow geographical scope. The public support is key but also creates risks for the sustainability of funding.

Actions at EU level:

Box 17. Combatting fragmentation – A highly integrated European federation of repairers – Option 1 (ambitious)

An ambitious measure at European level would consist of supporting the set up and functioning of a European federation of professional repairers. Such a federation would bring together existing and emerging networks of repairers and offer common tools and resources. It could be responsible for ensuring equivalent quality standards for repairers across the EU (see recommendation 2.3), by defining common minimum requirements for networks of repairers verifying quality standards and allowing mutual recognition of such certifications. The federation could develop a common EU brand or label (see recommendation 2.3.) to increase the visibility of and trust in repair services. This would facilitate the identification of trustworthy repairers by Europeans that are traveling or living in other Member States and increase brand recognition. It could develop common tools mapping and guiding consumers to repair services, using a data space approach (facilitating the pooling of existing data sources). It could encourage members of the network to jointly purchase spare parts (while respecting competition rules), to compensate the imbalance in market power with manufacturers. Finally, the federation could facilitate information sharing, training and advocacy (see option 2 below). Considering the significant effort needed to build such a network, it could benefit from EU funding to support its set up and functioning.

Box 18. Combatting fragmentation– A loosely integrated European network of repairers - Option 2 (moderate)

A more moderate alternative would consist of establishing a European network or repairers providing a common platform to allow the exchange of knowledge, best practices, online training resources, and to identify common challenges to be addressed at EU level. Such a network could identify and make available to members existing training resources and information on how to repair devices (in collaboration with platforms like iFIXIT). It could also develop new training or translate existing trainings in other European languages. The network would also allow a better representation of repairers at European level, facilitating their participation in European policymaking. It could develop communication toolkits or run campaigns at European level to raise awareness on the benefits on repair. It should build on existing initiatives and associations, such as RREUSE[335].

[331] Project under the European Territorial Cooperation programme Interreg NWE, running from 2019 to 2023. https://www.nweurope.eu/projects/project-search/sharepair-digital-support-infrastructure-for-citizens-in-the-repair-economy/#tab-1

[332] https://www.nweurope.eu/projects/project-search/sharepair-digital-support-infrastructure-for-citizens-in-the-repair-economy/project-results/towards-a-dataspace-for-repair/

[333] https://openrepair.org/members/

[334] Lechner et al. (2021)

335 RREUSE is an international non-profit network supporting the development of social enterprises in the field of re-use, repair and recycling. RREUSE counts 31 member organisations spread across 29 countries. About us | RREUSE

Box 19. Combatting fragmentation – Option 3 (basic)
The European Commission could encourage Member States, for example via a toolbox or through an expert group, to develop local, regional and national repair networks. It could foster the exchange of best practices between Member States, regions and cities on how to launch, support and sustain such networks.

5.6 Recommendation 7: adapt guarantee warranty schemes to encourage sustainable practices

Rationale: Currently, customers have to be provided with free repair, replacement, price reduction and reimbursement if the product is faulty or does not match the claims the company made about the product. There is a minimum 2 year legal guarantee in case of faulty products.[336] For second-hand goods the guarantee period can be shorter, but has to be a minimum of 1 year.[337]

In addition to legal guarantees, commercial guarantees could be used to stimulate sustainability and repair. However, these are largely unregulated and could even lead to less sustainable behaviour (e.g. if direct replacement is promised rather than repair or the requirement of company-own repair only)[338][339]

Warranties for second-life products should be extended to match those of new products. Allowing for shorter warranty in case of used spare parts might incentivize the use of second-hand spare parts[340].

Box 20. Warranty schemes – Option 1 (ambitious)
Companies have to **indicate the lifetime of the product and provide repair** within this timeframe. If the product was to break down before the indicated lifetime, the company is required to provide a **repair voucher** that can be used with an independent repair shop equally as with the company to have the product repaired. The added value of this option are the low costs for the government and the shifted responsibility to the company to ensure product quality and long life-span. At the same time it ensures that independent repairers are not excluded from the market.

Box 21. Warranty schemes – Option 2 (moderate)
During the warranty period, companies have to **provide vouchers to have the product repaired by any independent repairer**. This ensures that independent repairers are not excluded from the repair market but customers will have the right to have their product repaired in a fast and easy manner.

Box 22. Warranty schemes – Action 1 (basic)
Prefer repair (refurbished models) over replacement in guarantee remedies

Within the legal guarantee the customer has a right to a new product in case of a defect product. One argument to include sustainability in the legal guarantee would be to allow the replacement of defect products with **refurbished ('as new') products** with the same guarantee period as new phones, thus extending the right to repair to the manufacturers themselves in certain cases.

Action 1 (box 22) could be implemented in combination with option 1 (box 20) or option 2 (box 21).

There are several other options that could still be further explored. For instance, how to encourage manufacturers to offer a commitment to repair. Commitments could function in a similar way to manufacturer guarantees. Consumers have high trust in these guarantees, and they would be more likely to seek repair of a product if it is covered by a guarantee.

[336] https://europa.eu/youreurope/business/dealing-with-customers/consumer-contracts-guarantees/consumer-guarantees/index_en.htm
[337] Directive (EU) 2019/771
[338] Terryn (2019)
[339] Tonner (2017)
[340] Türkeli et al. (2019)

5.7 Recommendation 8: promote access to spare parts and repairable products

Rationale: There are several measures that could be introduced to encourage reuse and refurbishment, especially with regards to broken or unused electronic devices stored at homes.

Examples: There are considerations for a deposit scheme for electronic equipment. Some countries, for instance Austria and Germany, already have collection schemes for old devices, such as phones and batteries. Deposit schemes could also get further inspiration from schemes for, for instance, drinking bottles. This is based on suggestions from French law on reducing the footprint of digital equipment. While this has not been adopted so far, this should be considered as an incentive for better end-of-life management and retention of the value of products.

Action at EU level: (Note: The actions presented below are not mutually exclusive and could be implemented in combination.)

Box 23. Access to spare parts – Action 1 (ambitious)

Introduction of a European-wide deposit scheme for electronic products

Under this deposit scheme customers have the right to return their products to the original manufacturer or via the store where they purchased their product at the end of its life-time. For this to function, every electronic device will be sold with a deposit and customers will receive a minimum amount of money when returning their device. (This amount should be transferable to different owners in case the product is resold or refurbished within its life-time.) The company is responsible for the proper management of their products at the end of the lifecycle with a fine for landfill.

Box 24. Access to spare parts – Action 2 (ambitious)

Another option could be a focus on the development of **electronic products as a service**, especially for laptops and tablets – with the responsibility for the lifecycle of the product with the company throughout the way, potentially a small repair fee to make consumers more cautious in the use of their product – This could be compulsory for work devices; and mandatory to implement for public organisations.

Offering products as a service could allow companies to retain ownership of their product, thus focussing more on repair and having a higher interest in extending the lifespan of the product. However, this business model could lead to dominance over the repair market and exclusion of independent repairers or spare part producers as the ownership remains with the original manufacturer.

Box 25. Access to spare parts – Action 3 (moderate)

In addition to mere collection of equipment, another measure could focus on **adapting the targets of organisations in charge of WEE management to promote repair** of digital equipment. This could be connected to relevant policies, such as the Extended Producer Responsibility requirements that define the conditions in which an electronic product can or should be collected, recycled and recovered (e.g. WEEE (2002/96/EC)[341]. Developing an appropriate quality management system to assure the quality of the collected waste destined for reuse in products would help ensure their reliability.

Box 26. Consumer trust – Action 4 (basic)

There could be a **national operation of collection for digital devices with return rewards**. In this respect, government services at national and local level must favor reuse and repair of unused functional IT equipment over recycling or depositing. Another aspect could include creating donation centres for collecting used electronic objects which are then forwarded to repairers, to either repair or reuse for spare parts.

[341] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32002L0096

5.8 Additional recommendations

Box 27. Additional recommendations to support the supply of repair

- Identify, assess and promote new business models with the potential, such as product-as-a-service or sharing economy models, through research.
- Support digitally-enabled solutions like 3D printing that could facilitate product repair and people's access to spare parts, for example through research and innovation actions .
- Encourage Member States to lift taxes hampering the development of sales of second-hand refurbished products. E.g. private copy levy (maintained following debate on the REEN law in France, but at a lower rate).
- Support tools and platforms helping consumers to find reliable repair services and promote the interoperability between existing platforms.
- Develop a toolbox and/or a platform for exchanges for municipalities, building on relevant existing initiatives and structures, to promote good practices to support repair at the local level
- Create a well-functioning EU market for secondary electronics

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List of abbreviations and definitions

ABS-PC	Acrylonitrile butadiene styrene - polycarbonate
B2B	Business to business
B2C	Business to company
CE	Circular Economy
CEAP	Circular Economy Actions Plan
CEI	Circular Electronics Initiative
CO_2-eq.	Carbon dioxide equivalent
DIY	do-it-yourself
EFSI	European Fund for Strategic Investments
EGF	European Globalisation Adjustment Fund
ERDF	European Regional Development Fund
ESF+	European Social Fund Plus
EU	European Union
EULA	End-user licence agreement
ICT	Information and communication technologies
ISO	International Organization for Standardization
IP	Intellectual Property
GDP	Gross domestic product
GHG	Greenhouse gas
GPP	Green public procurement
LCA	Lifecycle assessment
JTF	Just Transition Fund
Mt	Mega-ton
NGO	Non-governmental organisation
OEM	Original equipment manufacturer
OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
REEN	La voi visant à réduire l'empreinte environnementale du numérique (law to reduce the environmental footprint of the digital)
RRF	Recovery and Resilience Facility
R2R	Right to repair
SMEs	Small and medium-sized enterprises
UNETO	Union of Electrotechnical entrepreneurs
VAT	Value-added tax
VNI	Vereniging van Nederlandse Installatiebedrijven (Association of Dutch installation companies)
WEEE	Waste electrical and electronic equipment

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