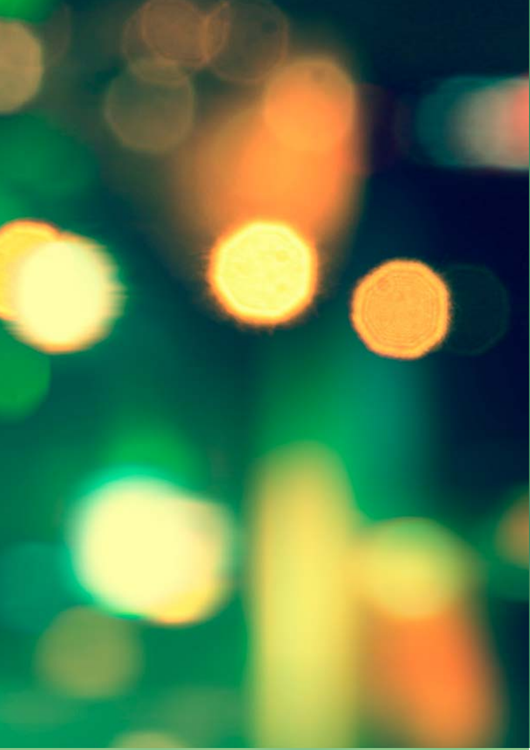

Increasing the lifespan of products

Policies and consumer perspectives

ER 2021:25

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Preface

The Ecodesign and Energy labelling regulations have been two of the EU's most effective tools in promoting energy efficiency.

As reflected in the EU Green Deal, the new Circular Economy Action Plan (CEAP) and the Ecodesign and Energy Labelling Working Plan 2020–2024, a more pronounced focus can now be seen on the more efficient use of materials in designing products, by different ways of prolonging product lifetimes and durability.

As an input to these initiatives and ongoing discussions, the Swedish Energy Agency has commissioned this report, to get an overview of the state of knowledge on a number of issues. Hence, the report provides an overview of a number of topics, including: What are the environmental effects of product lifetime extension? How are consumers likely to react to information about product lifetimes? What policies and standardisation activities are key in order to move towards a market where products have longer lifetimes and are easier to repair?

The information and views set out in this report are those of the authors and do not necessarily reflect the official opinion of the Swedish Energy Agency.

Linn Stengård, Head of Unit

This report was written by Carl Dalhammar, Leonidas Milios and Jessika Luth Richter. The authors are researchers at the International Institute for Industrial Environmental Economics (IIIEE) at Lund University.

Carl Dalhammar is currently involved in research related to circular economy solutions in manufacturing industry (in the Mistra-Rees program; mistrarees.se),and leads the project “CREACE: Creating a repair society to advance the Circular Economy – policies, networks and people” (repairsociety.blogg.lu.se) – a project on how to create a ‘repair’ economy. He has 20 years’ experience of research on policy and law, related to several topics including ecodesign, right-to-repair, planned obsolescence, energy efficiency, energy markets, and resource efficiency.

Leonidas Milios has 10 years’ experience of researching public policy related to a circular economy transition and a sound waste management. Currently, he is involved in the Mistra-Rees programme, investigating policy needs and appropriate policy responses to circular business barriers in the manufacturing sector in Sweden. Also, he participates in several international projects related to plastic waste management

Jessika Luth Richter is a postdoctoral research fellow at Lund University. She researches policies and initiatives enabling a circular economy, including extended producer responsibility (EPR) policies, ecodesign policies, green procurement, circular business practices and circular city initiatives, as well as trade-offs between circular strategies and policies with other environmental and social policies and impacts. She is currently doing research in the Formas-funded projects “Circular Economy: capturing value in waste through extended producer responsibility policies” and “CREACE: Creating a repair society to advance the Circular Economy – policies, networks and people” (www.repairsociety.blogg.lu). Jessika is also involved in teaching at the IIIEE, including design and running of massive open online courses about Circular Economy with over 30000 enrolments (www.coursera/learn/circular-economy/).

Innehåll

Svensk sammanfattning

Bakgrund

En nyckelstrategi inom den cirkulära ekonomin är att öka produkters livslängd. Detta kan göras dels genom att produkterna utformas så att de får ett längre liv, dels genom incitament för olika aktiviteter som ökar livslängden hos produkter och komponenter, såsom reparation, återbruk, och återtillverkning.

Vi ser allt fler styrmedel inom Europeiska unionen (EU) och dess medlemsstater som syftar till att ge incitament för aktiviteter hos tillverkare och användare som ökar produkternas livslängd. Inom EU-lagstiftningen så fokuserar de produktspecifika EU-förordningarna under ekodesigndirektivet alltmer på produkters livslängd och möjligheten att reparera produkterna. Det finns också förslag om ett obligatoriskt märkningssystem för produkters förväntade livslängd. EU:s medlemsländer har infört nationella styrmedel, t ex ändringar i konsumenträtten och lagstadgade konsumentgarantier, kriminalisering av planerat åldrande, ändrade skattesatser för reparationssektorn, reparationsindex, samt offentlig upphandling av återbrukade produkter.

Den svenska handlingsplanen för cirkulär ekonomi föreslår olika initiativ och styrmedel för att påverka produkters utformning och reparerbarhet, och ett flertal svenska myndigheter har fått olika uppdrag som relaterar till detta.

Dock finns ett antal frågeställningar relaterade till styrmedel för ökad livslängd hos produkter, vilka innebär en utmaning vid utformning av olika styrmedel. Dessa innefattar: Hur mäts och kommuniceras produkters livslängd och 'reparerbarhet'? Vilken typ av information om produkters livslängd kan konsumenter förstå och använda vid inköp? Finns det avvägningar mellan olika miljöaspekter? Exempelvis kan en långlivad produkt innebära att det tar längre tid innan man byter ut en produkt mot en mer energieffektiv modell, vilket innebär en avvägning mellan resursbesparing och energibesparing.

Syfte och metod

Rapportens syfte är att redogöra för kunskapsläget kring bland annat:

- Vilka är hindren för ökad livslängd och reparationer för produkter, och vilka styrmedel är viktigast för att överkomma dessa hinder?
- Vilka definitioner och standarder finns för koncept som 'livslängd' och relaterade termer?
- Vad säger forskningen om en 'optimal' produktlivslängd ur miljösynpunkt, och de avvägningar som finns mellan olika miljöaspekter?
- Vilket är kunskapsläget kring konsumenters kunskap och beteende relaterade till information om produkters förväntade livslängd?

Rapporten bygger i första hand på litteraturstudier. Semi-strukturerade intervjuer i pågående forskningsprojekt har också använts som underlag.

Definition av olika koncept och relaterade standarder

Rapporten går igenom olika engelska termer relaterade till livslängd, hållbarhet och reparation, liksom relaterade standarder. Livslängd kan mätas i olika enheter (år, cykler/serier, timmar i bruk, antal körda kilometer osv.), och val av lämplig enhet kan bero på produktegenskaper och hur produkten används.

'Teknisk livslängd'/'Funktionell livslängd' är den tid en produkt, maskin eller annan tillgång är funktionsduglig; innan den måste bytas ut mot en annan maskin/produkt. En produkts hållbarhet/livslängd beror på både inneboende produktegenskaper (produkt-design och materialkvalitet) och andra faktorer som korrekt underhåll, tillgång till reservdelar till rimligt pris, möjligheten att utföra reparationer till rimlig kostnad, tillgång till reparationsinformation etc.

'Optimal livslängd' kan vara olika saker, då man kan optimera utifrån olika parametrar, men här använder vi begreppet för att definiera den livslängd som är miljömässigt optimal (se nedan).

En produkts 'reparerbarhet' beror på både produktens tekniska egenskaper och externa faktorer som exempelvis tillgången till reparationstjänster och reservdelar. För närvarande pågår ett arbete med utveckling av ett poängsystem ('scorecard') inom EU, vilket kan lägga grunden till mer objektiva bedömningar av produkters reparerbarhet. Frankrike har också utvecklat ett nationellt reparationsindex.

Optimal livslängd och avvägningar mellan olika miljöaspekter

En kärnfråga vid bedömning av optimal livslängd rör den möjliga avvägningen mellan olika miljöaspekter. Ju längre en produkt används, desto större resursbesparingar kan uppnås. Men samtidigt kan äldre produkter med dålig energieffektivitet hållas kvar i bruk längre innan de byts ut mot en energieffektivare produkt, vilket ofta är negativt ur ett klimatperspektiv.

Studier indikerar att det, ur miljösynpunkt, alltid är en bra idé förlänga livet på ”passiva” produkter (t ex möbler och kläder) då de har liten eller begränsad miljöpåverkan vid användning. Detsamma gäller för produkter där större delen av miljöpåverkan ligger i extraktions- och produktionsfaserna (t ex mobiltelefoner), samt för produkter som sällan används.

När det kommer till energianvändande produkter med betydande miljöpåverkan i användningsfasen, så finns det avvägningar mellan olika miljöaspekter. De optimala livslängderna för dessa produkter beror på framförallt följande faktorer: elmixen (en hög andel fossilbaserad el ökar nyttan med att ersätta produkter med mer energieffektiva produkter), hur intensivt produkterna används, energiprestandan hos original- respektive ersättningsprodukten, samt – relaterat till detta – hur snabbt tekniken utvecklas mot mer energieffektiva produkter. I takt med att elmixen blir mer klimatvänlig så kommer miljönyttan av att förlänga livslängden också att öka. När produktgrupper når en punkt där energiprestandan inte förbättras nämnvärt mellan generationerna ökar också miljö-nyttan med en ökad livslängd.

Konsumentinformation om livslängd

Olika typer av informations- och märkningssystem kan hjälpa konsumenter att göra medvetna val på marknaden, men studier påvisar också att den ökande mängden märkningssystem kan skapa förvirring. Informations- och märkningssystem måste uppfylla vissa kriterier kring exempelvis ”förtroende”/”tillit” för att vara effektiva, men det är också viktigt att märkningssystem utformas på ett sätt som är enkelt att förstå. Vidare måste informationen sända en tydlig signal och uppmuntra ”miljöpositivt” beteende. Vi vet också olika demografiska grupper reagerar olika på miljöinformation (exempelvis beroende på kön, ålder och utbildningsnivå).

Vad gäller konsumentinformation om produkters hållbarhet/livslängd, så indikerar de studier som gjorts bland annat att:

- Information om produkters hållbarhet/livslängd kan öka konsumenters betalningsvilja, och göra konsumenter mer positiva till produkterna. Men dessa effekter kan variera mellan produktgrupper.
- ”Hållbarhet” (”durability”) är normalt sett en av de tre viktigaste faktorerna för konsumenter när de köper en produkt. Hållbarheten är starkt sammankopplad med ”produktkvaliteten” i stort, och information om produkters ”hållbarhet” får troligen större effekter är information om produkters ”reparerbarhet”.
- Det finns skillnader kring effektiv livslängdskommunikation: Studier som undersökt flera olika produktgrupper indikerar att det som fungerar för en produktgrupp inte behöver fungera för en annan produktgrupp.
- En livslängdsmärkning får troligen störst genomslag om märkningen sitter på produkten, och tydligt kommunicerar livslängden (uttryckt i år eller annan enhet).
- Den demografiska grupp som är mest mottaglig för en hållbarhetsmärkning är kvinnor i åldern 25–35 år.

Det finns indikationer på att konsumenter vill att vissa produktgrupper ska ha en längre livslängd, men ser vissa problem när det gäller ökad livslängd hos andra produktkategorier. Vi kan också notera att konsumenter har begränsad insikt i ”totalkostnaden för ägande” (”total cost of ownership”), och ofta saknar tillgång till tillförlitlig information om detta.

Effektiv märkning för livslängd/hållbarhet bör åtföljas av pedagogiska informationsinsatser så att konsumenter kan ta till sig budskapet och använda märkningen på ett bra sätt. Det kan finnas anledning att uttrycka livslängden i andra enheter än ”år”, och detta kan också förhindra att konsumenter blandar ihop märkning om förväntad livslängd med juridiska garantier (enligt konsumentköplagen) respektive kommersiella garantier, vilka uttrycks i år.

Om det blir vanligare med information om produkters livslängd/hållbarhet, kan vi förvänta oss att konsumenter i ökande grad beaktar dessa produktegenskaper vid köp i framtiden (”spill-over effects”).

Hinder och styrmedel för längre livstid och ökning av antalet reparationer

”Planerat åldrande” (”planned obsolescence”) som strategi hos tillverkare är relativt ovanligt. ”För tidigt åldrande” (”premature obsolescence”) – d.v.s. att produkten inte håller så länge som konsumenter förväntar sig, eller så länge som produktdesigners önskar – är däremot vanligt. Detta beror på olika faktorer på marknaden (konsumentförväntningar, garantier, prispress, lagstiftning, innovationstakt m m) vilket gör att det kan vara svårt för en enskild tillverkare att påverka.

Det är mer vanligt att originaltillverkare har strategier som försvårar eller fördyrar reparationer, än att de har strategier för planerat åldrande. Viljan att reparera förhindras även av andra faktorer, såsom priset för reparationer och reservdelar, bekvämlighet, och den ekonomiska avvägningen mellan att reparera och köpa en ny produkt när den nya produkten kommer med en garanti.

Olika styrmedel för att påverka ovanstående, och dess för- och nackdelar, diskuteras i rapporten. Grön skatteväxling diskuteras dock inte då det hittills inte resulterat i konkreta åtgärder. Bland de viktigaste styrmedlen återfinns initiativ på EU-nivå (exempelvis ekodesigndirektivet, obligatorisk livslängdsmärkning av produkter), liksom nationella initiativ (konsumentlagstiftning, offentlig upphandling, ekonomiska incitament för reparationer m m).

Hur kan Sverige driva dessa frågor framöver?

Det absolut viktigaste är att påverka utvecklingen på EU-nivå, innefattande utvecklingen av nya standarder, nya krav inom ekodesigndirektivet, och ett märkningssystem för hållbarhet/livslängd. De nya ekodesignkraven relaterar mer till ”reparerbarhet” än ”livslängd”, och möjligheten att ställa minimikrav på livslängden bör övervägas för relevanta produktgrupper.

Det finns ett antal styrmedel som kan användas på nationell nivå, och dessa bör övervägas. Sverige bör också se på vilka styrmedel som ledande länder, såsom Frankrike, arbetar med. När det gäller styrmedel för att öka produkters livslängd och produktreparationer, så är ambitionerna i den nya svenska handlingsplanen för cirkulär ekonomi begränsade, och ett flertal styrmedel som föreslagits av forskare och olika organisationer saknas. Om Sverige vill vara ledande inom detta arbete bör ytterligare insatser övervägas.

List of abbreviations

B2B	Business-to-business
B2C	Business-to-consumer
CEN	European Committee for Standardization
CO2e	Carbon dioxide equivalent
CENELEC	European Committee for Electrotechnical Standardization
EEE	Electrical and electronic equipment
EOL	End-of-life
EPR	Extended producer responsibility
ETSI	European Telecommunications Standards Institute
EU	European Union
Dir.	Directive
GHG	Greenhouse gas
IEC	International Electrotechnical Commission
IMCO	Committee on the Internal Market and Consumer Protection
IP	Intellectual property
IPR	Intellectual property right
ISO	International Organization for Standardization
LCA	Life cycle assessment
LCC	Life cycle costing
LED	Light-emitting diode
LLCC	Least life cycle costs
MS	Member state (of the European Union)
MTBF	Mean operating time between failures
MTTF	Mean operating time to failure
MTTFF	Mean operating time to first failure
NGO	Non-governmental organization
OEM	Original equipment manufacturer
R2R	Right-to-repair
US	Unites States
WEEE	Waste electrical and electronic equipment

Definitions of key concepts

Commercial guarantee	Guarantee provided by manufacturer or seller, which should be distinguished from the 'Legal guarantee' (see below). The terms of the manufacturer's commercial guarantee could give you more advantages than the legal guarantee, but cannot be used to restrict the legal guarantee. (for more details see chapter 2)
Dismantling	Possibly irreversible taking apart of an assembled product into its constituent materials and/or components. (EU Ecodesign Regulations)
Disassembling	Reversible taking apart of an assembled product into its constituent materials and/or components without functional damage that would preclude reassembling, reuse or refurbishment of the product. (EU Ecodesign Regulations)
Durability	Ability to function as required, under defined conditions of use, maintenance and repair, until a limiting state is reached. (EN 45552:2020)
Ecodesign	A systematic approach which considers environmental aspects in design and development with the aim to reduce adverse environmental impacts throughout the life cycle of a product. (ISO 14006:2020)
Expected lifetime	The estimated functional lifetime.
Firmware	Software that is semi-permanently placed in hardware. (kb.netgear.com)
Function	See 'Primary function' and 'Secondary function'.
Functional analysis	Process that describes the functions of a product and their relationships, which are systematically characterized, classified and evaluated. (EN 45552:2020)
Functional lifetime	The total time period [during which] an asset/machine can technically perform/function before it must be replaced (greenfacts.org) [Note: lifetime does not have to be measured in 'time'; other units include number of cycles, hours in operation, kilometres driven etc.]

Guarantee	Any undertaking by the retailer or a manufacturer, importer or authorized representative to the consumer to: a) reimburse the price paid; or b) replace, repair or handle appliances in any way if they do not meet the specifications set out in the guarantee statement or in the relevant advertising. (EU Ecodesign Regulations)
Hardware	Any physical electronic device.
Intended use	Use in accordance with information provided with a product or system, or, in absence of such information, by generally understood patterns of usage. (EN45552:2020)
Legal guarantee	The legal guarantee is binding on the trader, as it is stipulated in consumer law, and cannot be void through contractual arrangements (for more details see chapter 2)
Limiting event	Occurrence which results in a primary or secondary function no longer being delivered [Examples of limiting events are failure, wear-out failure or deviation of any analogue signal] (EN45552:2020)
Limiting state	Condition after one or more limiting event(s) [Note 1: A limiting state can be changed to a functional state by maintenance or repair of the product; note 2: A limiting state can change to EOL-status if maintenance or repair is no longer viable due to socio-economic or technical reasons. (EN45552:2020)
Maintenance	Action carried out to retain a product in a condition where it is able to function as required. (EN45552:2020)
Normal use	Use of a product, including its transport and storage, or a process, in accordance with the provided information for use or, in the absence of such, in accordance with generally understood patterns of usage. [Note: Normal use should not be confused with intended use.] (EN45552:2020)
Part	Hardware, firmware or software constituent of a product. (EN45552:2020)
Planned obsolescence	A group of techniques through which a manufacturer or a marketer seeks to deliberately reduce the life cycle of a product in order to increase its replacement rate. (French Consumer Code Articles L441-2)

Premature obsolescence	This concept has no formal definition, but describes a situation where products break down faster than expected and/or cannot be repaired due to design or cost reasons. Whether the breakdown of a product is premature can be measured against a standard, e.g. a consumer guarantee, a legally set requirement on product lifetime, or reasonable consumer expectations.
Primary function	Function fulfilling the intended use [Note: There can be more than one primary function]. (EN 45552:2020)
Professional repairer	'Professional repairer' means an operator or undertaking which provides services of repair and professional maintenance of refrigerating appliances. (EU Ecodesign Regulations)
Reliability	Probability that a product functions as required under given conditions, including maintenance, for a given duration without limiting event. (EN 45552:2020)
Repair	Process of returning a faulty product to a condition where it can fulfil its intended use. (EN 45554:2020)
Secondary function	Function that enables, supplements or enhances the primary function(s). (EN 45552:2020)
Software	The programs running on hardware. (kb.netgear.com)
Spare part	'spare part' means a separate part of an EEE that can replace a part of an EEE. The EEE cannot function as intended without that part. The functionality of EEE is restored or is upgraded when the part is replaced by a spare part'. (RoHS Directive. Art. 3:)
Technical lifetime	See 'Functional lifetime'.
Upgrade	Process of enhancing the functionality, performance, capacity or aesthetics of a product. (EN 45554:2020)
Warranty	See 'Guarantee' (the terms warranty and guarantee are often used interchangeably; note that they can have different meanings in different jurisdictions).
Wear-out failure	Failure due to cumulative deterioration caused by the stresses imposed in normal use. (EN 45552:2020)

1 Introduction

This chapter provides relevant background for the report. It also introduces the objective, methods, and outline of the report.

1.1 Product lifetime extension as a Circular Economy objective in Europe and Sweden

Realizing the vision of the circular economy requires a multitude of policy interventions.[1] Adopting a coherent policy framework will be crucial in order to guide market actors towards more resource-efficient solutions, and policy support is often needed for circular business models that are trying to compete in the current, 'linear' economy.[2] Some policy interventions are of outmost importance in order to move forward, including:[3]

- policies for the promotion of product durability, reuse, repair and remanufacturing;
- green public procurement and innovation procurement to support circular business models and innovative solutions and
- policies for improving secondary materials' markets, such as the market for plastics recycling.

The first category above (and, to a lesser extent, the second one) has been subject to several recent policy initiatives in the European Union and national governments, and also in the United States (US). Some of the relevant activities are outlined in table 1.

The common denominator is that these policies are trying to incentivize longer product lifetimes, which can happen through:

- incentivizing a *product design* that makes the product more durable and repairable, or
- enable *associated activities* that prolong the service life of products or components, such as re-use, repair, reconditioning, remanufacturing, upgrading, and repurposing.[4]

[1] Wilts and O'Brien, A Policy Mix for Resource Efficiency in the EU: Key Instruments, Challenges and Research Needs, *Ecological Economics*, vol. 155 (2019), 59–69; Milios, Advancing to a Circular Economy: three essential ingredients for a comprehensive policy mix, *Sustainability Science*, vol. 13 (2018), 861–878; COM(2020) 98 final.

[2] Milios, *Policy Framework for Material Resource Efficiency – Pathway Towards a Circular Economy*, 2020.

[3] Milios, 2018.

[4] These concepts are discussed in the next chapter

Table 1. Examples of adopted and proposed policies to increase product lifetimes.[5]

	European Union	EU Member States	Other (local/regional)
Adopted	**Ecodesign Directive:** new mandatory requirements on products placed on the EU market; related to durability, repairability, provision of spare parts etc. **Standardization** activities to develop new product standards on concepts such as 'durability, 're-use', 'repairability' and 'recyclability'; will make it easier to regulate these issues in future laws (ongoing process) **Consumer law**: Laws that allows consumer to require repairs of faulty products even when sellers would like to replace it with a new product (Dir. 2019/771)	**Criminalizing planned obsolescence** (France) **Fines for planned obsolescence** (Competition authority of Italy) **A repairability index** to inform consumers about the possibility to repair a product (France) Strengthening **legal** (mandatory) **product guarantees** in consumer law (several EU countries) **Tax reliefs for repair** (e.g. Sweden) **National accreditation** of re-use organizations (e.g. Belgium)	**Public procurement** of remanufactured ICT and furniture (e.g. Sweden) **Re-use parks and similar infrastructure**; diverting EOL products towards re-use **Networks for re-use**, including infrastructure, quality controls and marketing (e.g. the Flemish re-use network) Encouraged **use of remanufactured spare parts** for federal government vehicle fleet maintenance (e.g. USA) **Government support for private re-use firms** (e.g. Sweden) **Quality labels for re-used goods** to instil consumer confidence reg. quality
Proposed	**Consumer law** changes to ensure that consumers receive trustworthy information on product lifespan, the availability of repair services, spare parts and repair manuals **Measures to promote right-to-repair** (R2R) **Public procurement** criteria for remanufactured goods	**National public procurement** criteria for remanufactured goods like furniture and ICT products (under development) **Standards and quality labelling** schemes for re-used products (under development)	**Right-to-repair (R2R) laws** proposed in several US states; including several provisions to enable consumers to repair their products and allow independent repairers to access the aftersales market

At the EU level, future policies related to product lifetime and repairability, and consumer information, are expected in several policy areas. These include policies proposed in the Circular Economy Action Plan,[6] the New Consumer Agenda,[7], the Sustainable products initiative[8] the IMCO[9] Committee's recent vote on proposed policies,[10] and the

[5] Amended version of table in Dalhammar et al., Legal and organisational issues when connecting resource flows and actors: re-use and producer responsibility schemes for white goods, in *Proceedings of the IS4CE2020 Conference of the International Society for the Circular Economy*, Exeter: University of Exeter, 2020a.

[6] COM(2020) 98 final.

[7] COM(2020) 696 final.

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

[9] The European Parliament's Committee on Internal Market and Consumer Protection (IMCO).

[10] See https://www.europarl.europa.eu/committees/en/towards-a-more-sustainable-single-market/product-details/20201020CAN58063

European Parliament's resolution on 25 November 2020[11] which stresses the need for communicating product lifetime and repairability to consumers and the need for a mandatory labelling scheme.

It is likely that future policies will result in three key policy developments:

- product regulation addressing lifetime and repairability (such as regulations set under the Ecodesign Directive);
- labelling initiatives to inform consumers about expected lifetime and repairs (possibly under the Energy Labelling Framework Regulation, and/or through a new labelling scheme, and/or under existing eco-labels) and
- new consumer legislation and initiatives.

What we can notice in table 1 is that EU member states are using different types of legal frameworks to promote longer lifetimes and repair, including criminal law, competition law, tax law and consumer law.[12] Further, in order to promote the independent repair sector, and allow better opportunities for consumers to repair their products, there is a need to address intellectual property rights (IPRs) that are used by original equipment manufacturers (OEMs) in order to stop consumers from undertaking repairs, or force consumers to go to certain repairers.[13] Therefore, policy proposals on 'right-to-repair' also has implications for IPR law.

In the Swedish Circular Economy Strategy from 2020, there are several stated aims related to policies for product durability and longer lifetimes, such as:[14]

- steering towards a situation in which products are designed to have a long lifespan;
- improving consumer information to make it easier for individual consumers to make sustainable and circular choices in their everyday lives;
- making it simple and profitable for business operators and private individuals to share, repair and re-use products;
- contributing to resource efficiency, recycling and circular business models through public procurement;
- designing policy instruments that contribute to increased supply of and demand for circular products and services and re-used and recycled materials.

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11 European Parliament resolution of 25 November 2020 Towards a more sustainable single market for business and consumers (2020/2021(INI)).

12 EU member states cannot regulate product design directly; such rules should be set at the EU level as they strongly affect the Internal Market. There is more space for national measures in other areas of law, such as criminal law and consumer law.

13 Svensson-Hoglund et al., Barriers, enablers and market governance: A review of the policy landscape for repair of consumer electronics in the EU and the U.S., *Journal of Cleaner Production*, vol. 288 (2021), 125488.

14 Regeringskansliet, *Cirkulär ekonomi – strategi för omställningen i Sverige*, 2020. https://www.regeringen.se/4a3baa/contentassets/619d1bb3588446deb6dac198f2fe4120/200814_ce_webb.pdf

The 2021 Swedish Action Plan for the Circular Economy[15] announces some measures to promote longer product lifetimes and product repairs.

The Swedish government has also directed its central authorities to work with these issues. In the Government's instructions for the Swedish Energy Agency for 2020[16] and 2021[17], the Agency is instructed to promote circular economy issues like product lifetime, resource efficiency, repairability and recyclability in EU product legislation. Further, the agency is requested to coordinate their efforts with other Swedish authorities.

1.2 Complex issues related to regulation and information about lifetime and repairability

Policies promoting longer product lifetimes is a key strategy for realizing the vision of the circular economy as longer lifetimes can save resources. For most product groups, it is beneficial to prolong the lifetime of a product even if it could be replaced with a more energy-efficient product[18] (this is discussed in detail in chapter 6). Longer lifetimes are especially beneficial for products with significant life cycle environmental impacts in the extraction and production phases compared to use phase, such as consumer electronics, and "passive" products that have very limited impacts in the use phase, such as furniture.[19]

Emerging policies that promote longer product lifetimes and repairability have strong support among citizens, consumer NGOs, as well as politicians across the political spectrum. However, adopting such policies is no easy task.

A first issue concerns how we best measure, communicate and regulate lifetime and repairability. Consumers often think of product durability in terms of 'years in operation' (except for very durable products like cars), as legal guarantees and warranties for most products are expressed in years. However, for many products it may be more relevant to regulate e.g. 'hours in operation'. For some product groups, like LED lamps, "durability" is a multidimensional concept (see chapter 4). It can also be hard to measure issues such as how repairable a product is. Therefore, a number of supporting standards have been developed related to these issues, in order to assist future regulations (see next chapter and chapter 4).

A second issue concerns what kind of policy interventions would be best suited to prolong product lifetimes and repairability. Mandatory ecodesign standards may be suitable in some cases, but less relevant for other product groups. This applies especially to products where the technology is still under rapid development, or where it is complicated to set requirements. For some product groups under the Ecodesign Directive, the European Commission has made use of voluntary commitments as an alternative

[15] Ibid.

[16] Regeringen, *Regleringsbrev för budgetåret 2020 avseende Statens energimyndighet*, 2019. https://www.esv.se/statsliggaren/regleringsbrev/?RBID=20349

[17] Regeringen, *Regleringsbrev för budgetåret 2021 avseende Statens energimyndighet*, 2020. https://www.esv.se/statsliggaren/regleringsbrev/?rbid=21184

[18] Stamminger et al., Towards a durability test for washing-machines, *Resources, Conservation and Recycling*, vol. 131 (2018), 206–215.

[19] Böckin et al., How product characteristics can guide measures for resource efficiency – A synthesis of assessment studies, *Resources, Conservation and Recycling*, vol. 154 (2020), 104582.

approach,[20] and this could be one way forward also for resource-related requirements in some cases. However, there are also alternatives to ecodesign regulations, such as consumer laws, labelling and public procurement, which could be more relevant in some cases than ecodesign requirements; for instance for products that are hard to regulate due to problems in measuring lifetime, or lack of appropriate standards for showing legal compliance. In most cases, a policy mix making use of several instruments is the best way forward.

Further, in order to increase consumer repairs, we need to address other policy areas. As an example, intellectual property rights (IPRs) are often used by OEMs who want to restrict repair options for consumers, and therefore we need to address also IPR policies in order to promote repairs.[21]

We also need to address various trade-offs when designing policies. For instance, it may not be optimal to set standards for durability of products under rapid technological development, such as LEDs, as this may have negative implications for energy use and climate change objectives.[22]

Thus, regulators need to carefully consider issues like the life cycle environmental impacts, consumer behaviour and 'technology maturity' when considering policy measures for any given product group.[23]

More generally, there are also trade-offs between various environmental policies and laws which address different environmental aspects in different life cycle phases of products. This means we need to work to advance a coherent policy framework and minimize the conflicts, when designing policies for the circular economy[24] (see chapter 5).

Further, several other issues complicate policymaking. For instance, product lifetimes are not just about product design and accessibility of reasonably priced spare parts, but product durability and usability are also influenced by hardware-firmware-software interactions.[25] Therefore, policies need to consider these issues.

Consumer behaviour is also an important factor: if we design very durable products but consumers still choose to discard them while still fully functional, this is a case of over-engineering.[26] This would constitute a waste of resources.

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[20] For example, complex set-top boxes, imaging equipment and games consoles; see e.g. Dalhammar, et al., Energy Efficiency Regulations, Market and Behavioural Failures and Standardization, in *Preventing Environmental Damage from Products – An Analysis of the Policy and Regulatory Framework in Europe*, p. 176–228, 2018.

[21] Svensson-Hoglund et al., 2021.

[22] Richter et al., Trade-offs with longer lifetimes? The case of LED lamps considering product development and energy contexts, *Journal of Cleaner Production*, vol. 226 (2019a), 195–209. However, setting quality requirements – including requirements on minimum lifetimes – can be important in order to instill consumer confidence in new technology.

[23] Böckin et al., 2020.

[24] See e.g. Technopolis Group, *Regulatory barriers for the Circular Economy – Lessons from ten case studies*, 2016.

[25] For an overview, see Svensson-Hoglund et al., 2021.

[26] Here, we understand over-engineering (over-kill) as the act of designing a product to be more robust or have more features than is typically necessary for its intended use.

However, we should be careful to accept arguments related to over-engineering, and other arguments against regulation, at face value, because:

- Interviews with industry indicates that if industry is forced by regulation to design more durable products, they would probably alter their business models to capture more 'value' from the longer product lifespan.[27] Thus, what happens on the market is a mix of product design, business offerings, and consumer habits and consumer culture, but if one of these factors change, other changes may follow.
- Generally speaking, high product quality is an important parameter for repair, re-use, remanufacturing and reconditioning of products (these concepts are discussed in chapter 2). Thus, there can be no useful second life of cheap, low-quality products and components, as it makes no economic sense to invest in their continued 'survival'.[28] Thus, an important pre-condition for a circular economy is high product quality, for most products put on the market.[29] Of course, this may be controversial if higher quality equals higher purchasing costs, which may be problematic to afford for low-income households. It should however be noted that: 1) There is some correlation between product price and quality, but this relationship is not necessarily straightforward; 2) Buying high-quality products is often a good idea also for low-income households.[30] If they lack the means to pay upfront, it is important that they have access to instalment schemes;[31] 3) There are many "misconceptions" regarding the relationships between product quality, product price and the environmental performance of products. For instance, environmentally friendly products are often more expensive than conventional products, but they are not necessarily more expensive because they are environmentally friendly, but due to other reasons.[32] This is one reason why progressive product regulation and mandatory ecodesign standards will usually not lead to increased costs for consumers[33], or industries[34]. This also means that there is probably a large potential to increase the average product quality and environmental performance of many product groups without imposing significant additional costs to consumers.

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[27] Dalhammar, Industry attitudes towards ecodesign standards for improved resource efficiency, *Journal of Cleaner Production*, vol. 123 (2016), 155–166.

[28] See e.g. Maitre-Ekern and Dalhammar, Towards a hierarchy of consumption behaviour in the circular economy, *Maastricht Journal of European and Comparative Law*, 2019. https://doi.org/10.1177/1023263X19840943

[29] We could of course argue that an alternative strategy is to have cheaper products with a high potential for recycling of materials. But this is probably not a good strategy, for several reasons. We will not further discuss these issues here.

[30] Cf. the well-known saying: "Poor people can't afford cheap things."

[31] Cf. e.g. Hammond and Prahalad, Selling to the Poor, *Foreign Policy*, 2009. https://foreignpolicy.com/2009/10/27/selling-to-the-poor/

[32] Siderius, The role of experience curves for setting MEPS for appliances, *Energy Policy*, vol. 59 (2013), 762–772.

[33] Van Buskirk, et al., A retrospective investigation of energy efficiency standards: policies may have accelerated long term declines in appliance costs. *Environmental Research Letters*, vol. 9 (2014), 114010; Siderius, 2013; Taylor, et al., Confronting regulatory cost and quality expectations: An exploration of technical change in minimum efficiency performance standards, *Resources for the Future*, 2015. https://www.rff.org/publications/working-papers/confronting-regulatory-cost-and-quality-expectations-an-exploration-of-technical-change-in-minimum-efficiency-performance-standards/

[34] Dalhammar et al., 2018.

1.3 Objective and methods

The aim of this report is to account for the current state of research in relation to:

- Barriers and drivers for longer product lifetimes.
- How product lifetime and repairability can be measured, defined and regulated for various product groups, and the standards and ecodesign strategies that can support such developments.
- Various policy conflicts in the circular economy context, e.g. how various product rules may be in conflict.
- Current knowledge about the environmental impacts of increased product lifetimes, including trade-offs between parameters such as resource efficiency and energy efficiency.
- What we know about consumers' knowledge and behaviour in relation to various labels and information schemes, which can be used to convey information about product durability, quality and lifetimes.
- What we know about the advantages and drawbacks of using different policy instruments to promote product durability and repairability.

The main method employed is a literature review. When relevant, we also refer to recent interviews conducted with relevant stakeholders as part of our ongoing research projects MISTRA-REES, Value From Waste, and CREACE.

1.4 Outline

The report is developed according to the following outline:

Chapter 2 accounts for key concepts and definitions applied in this report.

Chapter 3 summarizes the main barriers for longer product lifetimes and repairs.

Chapter 4 reviews how product lifetime and repairability can be measured, defined and regulated for various product groups, including how this is done in existing policies, and the standards that can support such developments. It also makes an inventory of adopted and proposed criteria under the Ecodesign Directive.

Chapter 5 reviews examples of policy conflicts in the circular economy, with a focus on conflicts between various product regulations.

Chapter 6 reviews the literature on the environmental impacts of increased product lifetimes, including trade-offs between parameters such as resource efficiency and energy efficiency.

Chapter 7 accounts for the literature on consumer attitudes and knowledge related to information about product lifetime and repairability, and what we know based on studies of various product labels.

Chapter 8 discusses the respective advantages and drawbacks of different policy instruments that can be used to regulate product lifetime and repairability. It also discusses some main principles for an effective policy mix for promoting longer product lifetimes.

Chapter 9 summarizes the main findings of the study and provides recommendations on the ways forward.

In addition, the report contains four annexes, for the convenience of the reader:

Annex I. Examples of EU product laws and regulations.

Annex II. Standards relevant for the circular economy: adopted or under development

Annex III. Examples of need for new standardization activities, for different sectors.

Annex IV. Examples of requirements related to durability and repairability in new Ecodesign Regulations

2 Concepts and definitions

This chapter accounts for concepts and definitions that are important in the context of circular economy policies, and for the regulation of product lifespan and repairability.

2.1 Durability, reliability, planned obsolescence, premature obsolescence, ecodesign, and design for repairability

Durability can be understood as "*the ability of a product to perform its function at the anticipated performance level over a given period (number of cycles/uses/hours in use), under the expected conditions of use and under foreseeable actions. Performing the recommended regular servicing, maintenance, and replacement activities as specified by the manufacturer will help to ensure that a product achieves its intended lifetime.*"[35]

In the European standard EN 45552:2020[36], durability is defined as:

Durability < of a part or a product >

ability to function as required, under defined conditions of use, maintenance and repair, until a limiting state is reached.

Regarding parameters for measuring durability, it is stated:

Durability can be expressed in units appropriate to the part or product concerned, e.g. calendar time, operating cycles, distance run, etc. The units should always be clearly stated.

EN 45552:2020 defines ***reliability*** as:

reliability

probability that a product functions as required under given conditions, including maintenance, for a given duration without limiting event

One difference between durability and reliability is that the latter concept does not include repairs. Thus, the reliability of a product may be 5 years of normal functionality, but the durability of the product may be 15 years if it undergoes repairs.[37]

The durability of a product depends on both *inherent product properties* (the product design and the quality of materials) and *other factors* such as proper maintenance, provisions of spare parts at reasonable cost, the potential to perform repairs at reasonable cost, access to repair information etc. (see also below).

Here, we consider the ***technical lifetime*** and ***functional lifetime*** of a product to be the same thing, namely 'the total time period [during which] an asset/machine can technically perform/function before it must be replaced'. For a review of other related concepts, see chapter 4.

[35] Boulos et al., *The Durability of Products – Standard assessment for the circular economy under the Eco-Innovation Action Plan*, 2015.

[36] EN 45552:2020 General method for the assessment of the durability of energy-related products.

[37] For discussion and examples, see SS-EN 45552:2020.

The concept ***optimal lifetime/optimal durability***, is usually considered to be the lifetime for a product that has the lowest environmental impacts.[38] This can be important for instance when switching from a product to a more energy-efficient one, as will be discussed in chapter 6. By weighing different environmental parameters against each other, and optimal lifetime can be established. This is how we use the expression optimal lifetime in this report. However, it is also possible to estimate optimal lifetimes based on other 'optimization parameters', e.g. the lowest life cycle costs for a consumer.[39]

In the European standard EN 45554:2020[40] ***repair*** and ***upgrade*** are defined:

repair

process of returning a faulty product to a condition where it can fulfil its intended use

upgrade

process of enhancing the functionality, performance, capacity or aesthetics of a product

[Note 1 to entry: An upgrade to a product may involve changes to its software, firmware and/or hardware.]

The repairability of a product is dependent upon both its design and other issues, as will be discussed below (see also EN 45554:2020).

For some other key terms, we use the definitions applied in the EU Ecodesign regulations set under the Ecodesign Directive (Table 2).

Table 2. Definitions relevant to product repairability.[41]

Concept	Explanation
Spare part	a separate part that can replace a part with the same or similar function in a product In the RoHS Directive. Art. 3: 'spare part' means a separate part of an EEE that can replace a part of an EEE. The EEE cannot function as intended without that part of the EEE. The functionality of EEE is restored or is upgraded when the part is replaced by a spare part;'
Professional repairer	professional repairer' means an operator or undertaking which provides services of repair and professional maintenance of refrigerating appliances;
Guarantee	any undertaking by the retailer or a manufacturer, importer or authorized representative to the consumer to: (a) reimburse the price paid; or (b) replace, repair or handle appliances in any way if they do not meet the specifications set out in the guarantee statement or in the relevant advertising
Dismantling	possibly irreversible taking apart of an assembled product into its constituent materials and/or components
Disassembling	reversible taking apart of an assembled product into its constituent materials and/or components without functional damage that would preclude reassembling, reuse or refurbishment of the product;

38 See e.g. Bakker and Schuit, *The Long View: Exploring Product Lifetime Extension*, 2017.

39 Cf. Richter et al., Optimal durability in least life cycle cost methods: the case of LED lamps, *Energy Efficiency*, vol. 12 (2019b), 107–121.

40 EN 45554:2020 General methods for the assessment of the ability to repair, reuse and upgrade energy-related products.

41 These definitions are found in various Regulations adopted under the Ecodesign Directive 2009/125/EC

Warranties and guarantees are two terms that cause a lot of confusion. They are often used in different ways in different reports.[42] In EU law, the term guarantee is usually used.[43] The main important thing to consider is the difference between legal guarantees/warranties and commercial guarantees/warranties: The legal guarantee is binding on the trader, and cannot be void through contractual arrangements. The trader or manufacturer may also give you (or sell you) an additional commercial guarantee, whose terms and conditions are explained in your contract. The terms of the manufacturer's commercial guarantee could give you more advantages than the legal guarantee but cannot be used to restrict the legal guarantee.

Here, we use the term 'guarantee'. A guarantee is a term of a contract, breach of which gives rise to a claim for damages, but (usually) not the repudiation of the whole contract. As a baseline, consumers in most jurisdictions have a legally mandate guarantee for a certain period of time, often ranging from 1 to 3 years. Both in the EU and the USA, there are different rules in different jurisdictions related to warranties for consumers, but EU rules state that legal consumer guarantees most be a minimum of 2 years. Some jurisdictions such as Iceland and Norway also provide consumer rights for non-conforming products for a longer period of 5 years when the products are meant to last for a considerably longer time.[44] It should be noted that it is not only the general warranty that is of importance; in some jurisdictions, producers' claims about lifetime could lead to a consumer claim if the product falls short of its indicated lifetime, as this can constitute a breach of satisfactory quality.[45]

It is not only the length of the warranty per se that is of importance, but also other factors, most notably when the 'burden of proof' for showing that a product defect was present at the time of purchase is transferred from seller to buyer, as this can be difficult to prove. In most EU countries, this burden of proof is moved from the seller to the buyer after 6 months (which is the minimum time stated in EU law). The EU NGO RREUSE has proposed that products can be more durable and repairable if the burden of proof lies with the seller/manufacture for 2 years instead of 6 months, and that this can be enforced through higher "Mean Time Between Failure (MTBF)" requirements for critical subassemblies such as those with electromechanical parts/components.[46]

EU law on consumer protection is a mix of acts that aim at minimum harmonisation and acts that aim at total harmonisation.[47] The main benefits of minimum harmonisation are that it secures minimum rights for the consumer while allowing Member States to strengthen consumer protection. The main drawback is that practices in EU Member

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[42] See also Richter et al., 2019a.

[43] Cf. Your Europe, *Guarantees and returns,* 2020. https://europa.eu/youreurope/citizens/consumers/shopping/guarantees-returns/faq/index_en.htm

[44] Tonner and Malcolm, *How an EU lifespan guarantee model could be implemented across the European Union*, 2017.

[45] Stone, How to Light: Do you know where you stand if an LED product fails early? *LuxReview*, 2015. https://www.luxreview.com/2015/04/17/promises-promises/

[46] RREUSE, *Improving product reparability: policy options at the EU level*, 2015. http://www.rreuse.org/wp-content/uploads/Routes-to-Repair-RREUSE-final-report.pdf.

[47] See also Maitre-Ekern and Dalhammar, 2019; Keirsbilck et al., *Sustainable Consumption and Consumer Protection Legislation*, 2020.

States differ, which forces producers to adopt different business practices throughout the EU.[48]

Whether guarantees actually provide incentives for product durability depends on the circumstances. When it comes to product that does not cost much, often consumers do not pursue a warranty claim, e.g. because the reward is limited compared to the effort. And, consumers may be suspicious towards warranty claims from firms that may be on the market only temporarily. Industry associations seem to view the use of warranties, reliability claims, etc., as good source of information for customers, but in reality, this mainly applies to professional users as private consumers cannot be expected to understand this information and assess its validity.

Generally, for most products groups, there are indications that EU companies prefer ecodesign requirements setting mandated minimum lifetime in hours, to mandated extended consumer in years. The reasons are likely that (1) guaranteeing lifetime in hours rather than years protects the producers from intensive product use by consumers and (2) mandated long warranty times undermine the lucrative business of selling longer warranties to consumers. [49]

For professional users, there is the option for producers to voluntarily offer extended warranties that include both replacements of faulty products and other services such as maintenance. The buyers can then choose a contract that suits their risk preferences and the technical installation. It is therefore doubtful if a mandated warranty should be legislated for B2B relations for all product groups.

The term ***planned obsolescence*** does not have an official EU definition. Oxford Dictionaries define it as '*a policy of producing consumer goods that rapidly become obsolete and so require replacing, achieved by frequent changes in design, termination of the supply of spare parts, and the use of non-durable materials*.

Planned obsolescence is however defined in French law. The French Consumer Code (Articles L441-2) state:[50]

'Planned obsolescence is defined as a group of techniques through which a manufacturer or a marketer seeks to deliberately reduce the life cycle of a product in order to increase its replacement rate.'

There are some examples where producers have deliberately shortened the life spans of products (light bulbs, printers, textbooks[51]), but in most cases of poor/limited product durability it is not a "planned" process per se. Rather, the OEMs invest in components and materials that are guaranteed to last for a limited number of years based on an estimation of consumer expectations, the customer segment, costs vs. benefits etc. In a study based on interviews with designers, Longmuss and Poppe argue that there is obsolescence, but it is not "planned" but related to current market conditions (see also next chapter).[52]

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48 Mańko, *Methods for unifying private law in the EU*, EPRS Briefings (No. 130628REV1), 2014.

49 Dalhammar, 2016.

50 This translation is taken from https://www.stopobsolescence.org/

51 Cf. Kahlin McVeigh et al., *Planned obsolescence – Built not to last*, 2019.

52 Longmuss and Poppe, Planned obsolescence: who are those planners?, in *Product Lifetimes And The Environment 2017 Conference Proceedings*, 2017.

Representatives of OEMs have also claimed that, generally speaking, the trend towards products with more functions[53], modes, and settings makes products more brittle: the more functions and components, the less robust is the design.[54]

Some OEMs (e.g. Miele) have a different strategy than many of its competitors, as they have built their brand reputation on providing high-quality, durable products.

While deliberate obsolescence may be quite rare, it is quite common that OEMs make use of various strategies and laws to discourage consumers from making own repairs or using independent (non-authorized) repairers[55] (see chapter 5).

Since planned obsolescence is rare, policymakers and other actors increasingly refer to ***premature obsolescence***. This concept has no agreed definition either, but it seems to be a concept to describe a situation where products break down faster than expected and/or cannot be repaired due to design or cost reasons.[56] Whether the breakdown of a product is premature can be measured against a standard, e.g. a consumer guarantee, a legally set requirement on product lifetime, or reasonable consumer expectations.[57] As stated previously, the concept of planned obsolescence is only defined in French law. The Italian Competition Authority has however showed that it is possible to combat practices associated with planned obsolescence, without the concept being defined in Italian law, through fining companies, under the Italian Consumer Code.[58]

Obsolescence can be of different kinds, see section 3.1, and be due to different factors.[59]

Ecodesign means the integration of environmental aspects into the product development process, by balancing ecological and economic requirements. Ecodesign considers environmental aspects at all stages of the product development process, striving for products which make the lowest possible environmental impact throughout the product life cycle.[60] There are many principles and strategies related to ecodesign, and multiple

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53 Here, we can understand the term 'function' as it is primarily used in engineering design, where the term function is generally used to refer to the technical actions performed by a product. Thus, if a fridge/freezer has an ice machine, it has added an extra function (compared to a traditional fridge/freezer). However, products accomplish a wider range of goals, and thus 'functions', apart from the mere technical ones. Thus the word function can have different connotations.

54 Based on interview with a representative for an OEM producing white goods, October 2020. The interviewee further claimed that (all) consumers do not always want more complex products: the OEM designers/engineers sometimes strive to add more functions and settings as they are trained to work in this way.

55 For examples, see Maitre-Ekern and Dalhammar, Regulating Planned Obsolescence: A Review of Legal Approaches to Increase Product Durability and Reparability in Europe, *Review of European, Comparative and International Environmental Law (RECIEL)*, vol. 25 (2016), 378–394; Svensson-Hoglund et al., 2021.

56 Other concepts have also been used, e.g. "negligent obsolescence" and "avoidable obsolescence"; cf. Brönneke, Premature Obsolescence: Suggestions for Legislative Counter-measures in German and European Sales & Consumer Law. *Journal for European Environmental & Planning Law*, vol. 14 (2017), 361–372.

57 Ibid.

58 For more details on this case, and more through discussion on the legal definition of 'planned obsolescence', see Michel, Is there a need to legally define practices of premature obsolescence?, in *Product Lifetimes And The Environment 2019 Conference Proceedings*, 2019.

59 Kahlin McVeigh et al., 2019.

60 See also ISO/TR 14062:2002 Environmental management – Integrating environmental aspects into product design and development.

ecodesign tools. We will not discuss these here, but some concepts are more closely related to design for repairability than others. The most important one is *design for disassembly, re-use and recovery*. Design for disassembly is a key issue for repairs as it affects the possibility for taking apart and fixing a product without harming it. Further, easy disassembly will reduce the time it takes to undertake repairs and thus also the cost of repairs. In the new EU Ecodesign requirements related to repairs, the EU has regulated this primarily through requirements for dismantling for material recovery, requiring that manufacturers, importers or authorized representatives shall ensure that products are designed in such a way that the key materials and components can be removed with the use of commonly available tools (see chapter 4). In fact, these are the only EU repair requirements related to product design per se, as the other EU Ecodesign requirement on repairs relates to the provision of spare parts, and rights of independent repairers to access repair manuals etc. (this is discussed in more detail in chapter 5).

The new European standard 'General methods for the assessment of the ability to repair, reuse and upgrade energy related products' (EN 45554:2020) makes it possible to measure the 'repairability' of a product. It will be discussed in the next chapter.

In addition, *modular product design* can support repairs as it makes repair easier, and it can also support upgrading strategies for products. Examples of modular designs include smartphones like the Fairphone that have modular components within the product[61]. Standards can also enable modularization and interchangeability of components between products, e.g. the Zhaga standard making lighting systems modular.[62] It is generally positive also for promoting other 'R' activities like remanufacturing and refurbishment (see below for definitions of these activities). However, modularity may also entail drawbacks, and there can be a trade-off between modular flexibility and product performance.[63]

Of course, other design characteristics are related to repair as well. The indications are that the most important parameters for consumers considering repairs is the price of the products: the more expensive the product, the more likely it is to be repaired.[64] This also means that governmental policies and laws, or corporate strategies, which push the market to design more high-quality products, are also drivers of repairs.

2.2 Repair, remanufacturing, refurbishment and related activities

While most people consider recycling to be a good thing, recycling is not the primary strategy to pursue in order to save resources for most product groups; realizing the vision of the circular economy necessitates that more focus is put on the 'inner loops' strategies for product, component and material circulation. These are the so-called 'R's', cf table 3. One current problem in circular economy is that policymakers wants to promote activities like repair and remanufacturing. Examples of 'repair' and several other related 'inner loop' practices are provided in table 3.[65]

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61 https://www.fairphone.com/

62 https://www.zhagastandard.org/

63 See Amend et al., Modularity, Design, and Circularity. A Review, in *Proceedings of the IS4CE2020 Conference of the International Society for the Circular Economy*, 6–7 July 2020, Exeter: University of Exeter, 2020.

64 Cf. Dalhammar (ed.) and Richter (ed.), *Promoting the Repair Sector in Sweden*, 2020.

65 Cf. also the Waste hierarchy in the Waste Framework Directive, Art. 4.

Table 3. The 'R's: Circular Economy activities.

Term	User	Level
Repair	First user	Product
Re-use	Second Hand	Product
Refurbish	Second Hand	Product
Repurpose	Second hand in another application	Product
Remanufacture	Second Hand	Component
Recycle	Same industry (closed) Any other industry (open)	Material
Recovery	Any	Energy/material

It is important to note that the activities listed above are often not clearly defined, and sometimes used interchangeably, in both literature and industry. For more discussion on the definitions we refer primarily to 1) relevant standards, 2) a recent report published by the Swedish Chemicals Agency[66], 3) a report by the International Resource Panel[67], and 4) a 2020 report by the European Commission.[68]

Thus, many key circular economy terms can be sources of confusion or overlapping meanings. For example, refurbishment processes cover a range of activities, from simple to extensive. There are major differences in the cost, energy requirement, emissions and waste generation, as well as the value (e.g. price) associated with the refurbished product. Refurbishment could happen in the garage of an individual; comprehensive refurbishment refers to refurbishment that takes place in controlled industrial settings, to meet specified performance standards. A major trade issue between the USA, EU, China, and other emerging economies relate to the lack of industrialized/standardized settings and performance requirements that are attached to 'refurbishment' and 'remanufacturing' activities.[69]

Another key term that is difficult to define is remanufacturing.[70] Unlike many of the other Rs, remanufacturing is not (explicitly) about product life-extension. This is because the product is completely disaggregated or deconstructed in the process; and when it is assembled, it is an entirely different product. The full new service life of the remanufactured product is ensured by rigorous testing and performance standards that require the product to meet or exceed the performance and quality specifications of a current new version of the same type of product. If it does not meet these standards, then it is not remanufacturing.[71]

66 Swedish Chemicals Agency, *Regulatory mapping for remanufacturing of products under EU law*, 2021.

67 International Resource Panel, *Re-defining Value – The Manufacturing Revolution*, 2018

68 European Commission, *Categorisation system for the Circular Economy*, 2020.

69 See e.g. Kojima, Remanufacturing and Trade Regulation, *Procedia CIRP*, vol. 61 (2017), 641–644; Saavedra, et al., Remanufacturing in Brazil: Case Studies on the Automotive Sector, *Journal of Cleaner Production*, vol. 53 (2013), 267–276; US International Trade Commission, *Remanufactured Goods: An Overview of the U.S. and Global Industries, Markets and Trade*, 2012.

70 Cf. Swedish Chemicals Agency, *Regulatory mapping for remanufacturing of products under EU law,* 2021. It should be noted that some researchers do not use the term 'remanufacturing', as they think it is not the proper term to denote these activities; however, the concept is now quite well established, and there are also established remanufacturing networks, such as 'The European Remanufacturing Network'.

71 International Resource Panel, *Re-defining Value – The Manufacturing Revolution*, 2018.

Many of the practices in the table above are related, in various ways. For instance, the ability of a product to be reused is influenced by its ability to be repaired or upgraded.[72]

2.3 Policies, policy instruments, and policy mixes

Public policy can be understood as a system of laws, regulatory measures, targets, courses of action (e.g. roadmaps, strategies), and funding priorities concerning a given topic promulgated by a public body. Policies can be adopted at various levels, e.g. the international, EU, national, regional and local levels. Of special importance for the circular economy efforts in Europe are the EU Circular Economy Action Plan, as well as several related EU strategies (including on resources, products and waste, and the new chemicals strategy), and the national circular economy roadmaps adopted by several EU member states (and associated strategies). Areas of importance for the circular economy and repairs include policies related to e.g. waste, resources, conflict minerals, product regulation, chemicals, standardization, taxes and industrial policy.

Policy instruments are specific governmental interventions aimed at achieving policy objectives, which provide actors with incentives to change behaviour. There are different classifications of policy instruments but most of them differentiate between administrative, economic and informative instruments ('sticks, carrots and sermons'). One example of a classification is provided in table 4.

Table 4. Common classification of policy instruments, including examples of policies in each category.[73]

	Mandatory instruments	**Voluntary instruments**
Administrative	Bans, licenses, requirement on information, producer responsibility targets, recycling and recovery quotas, material and quality requirements, emission levels, chemicals regulation, ecodesign regulations, consumer guarantees	CSR schemes and standards, application of product standards and tools like LCA and footprinting, product panels, agreements between government and industry
Economic	Deposit-refund systems, taxes and charges, liability rules, subsidies for green products, modular fees in EPR schemes	Green public procurement, technology procurement, public procurement for innovation (PPI), R&D investments
Informative	Requirement on information on e.g. conflict minerals and chemicals, emission registers, ecodesign requirements, material and quality requirements, chemicals regulation on information for professional and private users, energy labelling, marketing regulations	Ecolabelling ISO type I-III (ecolabels, EPDs, green claims), voluntary energy labelling, organic labelling of food, quality labelling of 2nd hand products, certification schemes, consumer advice, consumer campaigns, education, repair cafés

[72] See e.g. EN 45554:2020 General methods for the assessment of the ability to repair, reuse and upgrade energy-related products.

[73] Mont and Dalhammar, Sustainable consumption: at the cross-road of environmental and consumer policies. *International Journal of Sustainable Development*, vol. 8 (2005), 258–279.

Policy instruments are needed in order to reach sustainability policy objectives due to the manifold barriers, which may include various market failures and behavioural failures. Policy instruments – not least product regulation – can also reduce transaction costs for industry and consumers.[74]

There are also other types of policy interventions (than policy instruments) that are relevant for promoting the circular economy, including governmental funding of businesses or R&D, infrastructure solutions to promote re-use and recycling, education efforts in schools and universities, etc. Infrastructure solutions can include municipalities setting up recycling infrastructure to promote re-use of discarded products instead of recycling[75], or municipalities supporting re-use businesses in various ways.[76] Another example concerns when producer responsibility organizations (PROs) provide re-user access to end-of-life products from their material streams.[77]

Product standards are specifications and criteria for the characteristics of products, encompassing all types of technical specifications put on products, and testing procedures to show compliance with product regulations or other product specifications. Product standards can be mandatory or voluntary by nature and are developed by different actors – including governments and standardization bodies – for different purposes.

Product policies includes various public policies that in some way aim to change (through various incentives) the way products are designed, used, procured, repaired etc. They can be adopted at the EU level, or national level, and include mandatory rules, but also ecolabels, criteria applied in public procurement, and so on. Examples of such product policies are provided in the table in chapter 5.

Product regulations are key for incentivizing the characteristics of products. They include[78] 1) rules on producer responsibility (with targets for collection, recycling and recovery of products); 2) rules that influence chemicals in products (directly or indirectly); 3) the Ecodesign Directive which influence product design e.g. with regards to energy efficiency performance, and; 4) mandatory energy labelling, which communicates products' performance – especially related to energy efficiency – to consumers. Some relevant EU product laws are outlined in Annex I.

There are additional policies that aim to green the life cycle of products, such as public procurement, the EU ecolabelling scheme, and national ecolabelling schemes.

As there are many barriers for realizing sustainability objectives, ***a policy mix (or policy package)*** which combines several policy instruments is usually needed. A policy mix is a combination of policy instruments designed to address one or more policy objectives, in order to improve their total effectiveness, legitimacy and feasibility.

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[74] For an overview of these issues see e.g. Dalhammar et al., 2018.

[75] For instance, Alelyckan in Gothenburg: https://www.inno4sd.net/alelyckan-re-use-park-in-gothenburg-528

[76] One example is ReTuna in Eskilstuna, where the municipality supports re-use businesses in various ways; cf. https://www.retuna.se/english/about-us/

[77] Cf. Dalhammar et al., 2020a.

[78] E.g. Dalhammar, 2016.

2.4 Laws, standards and standardization

Laws can be adopted at different levels, including international law, EU law[79], national law, regional (state) law, and local law. It involves various legal fields, such as consumer law and criminal law.

Standards are defined by ISO as "*a document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context*".[80]

We can categorize standards in different ways (Table 5).

Table 5. Typologies of global standards.[81]

Field of application	Quality assurance Environmental Health Labour Social Ethical
Form	Codes of conduct Labels Standard
Coverage	Firm-/value- chain specific Sector-specific Generic
Key drivers	International business International NGOs International labour unions International organizations
Certification process	First-party Second-party Third-party Private-sector auditors NGOs Government
Regulatory implication	Legally mandatory Market competition requirement Voluntary

79 EU law includes several types of laws, most notably Directives and Regulations. We will not further discuss these issues in this report.

80 https://www.iso.org/sites/ConsumersStandards/1_standards.html

81 Nadvi and Wältring, *Making Sense of Global Standards*, 2013.

The term ***standardization*** is used to describe the process of developing new standards in standardization bodies (including ISO, IEC, CENELEC, ETSI and CEN). Here, the term 'standards' denotes standards developed by these standardization bodies. The use of these standards by companies are voluntary in principle but using them may be 'semi-voluntary' in practice. An example concerns if a large corporation require all their suppliers to adhere to a certain standard as a requirement for doing business. Further, EU product regulations often refer to the use of 'harmonized standards' as a way for corporations to demonstrate that their product comply with legal rules.[82]

Standards are very important as the basis for setting mandatory product criteria under EU product regulation: there must be standards in place in order to allow for the setting of requirements, and for companies to show compliance.[83] Further, standards are important for market surveillance authorities (MSAs) in order to check that products on the market are in compliance with relevant laws. See the picture below for one way of explaining the relations between the different layers.

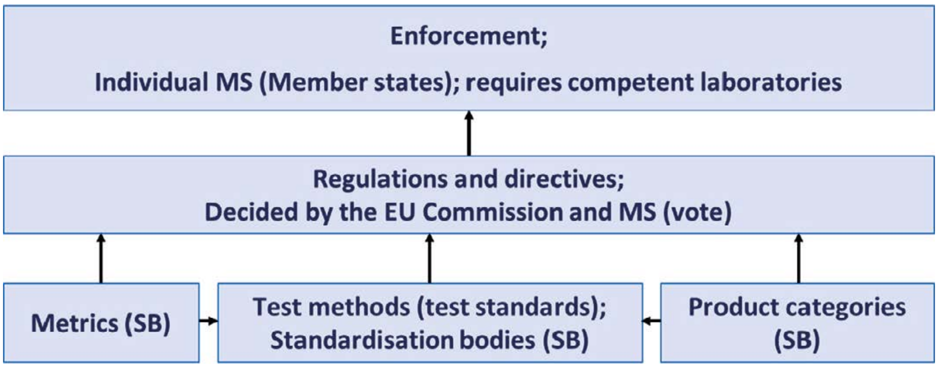

Figure 1. Enforcement system for EU product regulations.[84]

[82] We will not discuss the new approach and the law-standards relationship further in this report. For more information see e.g. https://www.cen.eu/work/supportlegislation/directives/pages/default.aspx (in English) or https://www.sis.se/standarder/vad-ar-en-standard/eu-och-standarder/ (in Swedish). For a more detailed discussion on harmonized standards see section 6 in Remmen et al., *Expanding the Scope of the EuP Directive*, 2011.

[83] See Tecchio et al., In search of standards to support circularity in product policies: A systematic approach, *Journal of Cleaner Production*, vol. 168 (2017) 1533–1546; Dalhammar et al. 2018.

[84] Figure by Peter Bennich, Swedish Energy Agency, 2021.

3 Barriers for longer product lifetime and repairability

Chapter 3 summarizes main barriers for extended product lifetimes and repairs.

3.1 Main drivers of premature obsolescence

Looking back, many consumer and professional products were more durable than they are today, and consumers were used to repairing and fixing them (on their own or through cobblers, tailors, blacksmiths etc.).[85]

A century ago, mass production techniques allowed for the production of larger volumes of standardized products. This led to worries that not all products could be sold (over-production), and that producing products with long lifetimes could lead to unemployment due to higher supply than demand of products in consumer markets. In this situation, shorter lifespans were seen as key to achieve political objectives like full employment.[86]

Several trends – including the emergence of lean manufacturing in all kinds of production systems, faster innovation cycles, and increasingly global supply chains – have led to a situation where many products are rather 'inexpensive' compared to the situation a few decades ago. Products like food, white goods and TVs used to cost much more, looking at indexed prices and as a percentage of disposable income. But at the same time, we get what we pay for, and many new products are not very durable.[87]

It is however not easy to get reliable information and data on product lifetimes, and we can expect lifetimes to be influenced by macroeconomic trends (such as shorter lifetimes in periods of strong economic growth, when people can afford to change products more often; and more repairs in countries and regions with lower disposable incomes).[88]

First of all, it should be noted that not all product groups have shorter lifespans than they used to, nor that product quality always decreases.[89] However, there is a general belief that many products have a shorter lifespan than they used to have, and a shorter lifetime that could be expected by consumers, and there is some evidence supporting this, including:

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[85] Slade, *Made to Break: Technology and Obsolescence in America*, 2007.

[86] Most famously expressed by B. London, *Ending the Depression through Planned Obsolescence*, University of Wisconsin, 1932.

[87] This does not imply that the relationship between product price and quality aspects such as durability are absolute: we have all bought cheap products that have good quality and are durable. And we have all bought expensive stuff that have poor quality. That being said, high-quality materials and components tend to be costlier than other material/components, and thus there is an important cost aspect to quality/lifetime for most products. And we have all experienced that the products sold at the lowest price at low-cost retailers tend to break very quickly.

[88] Bakker et al., Products that go round: Exploring product life extension through design. *Journal of Cleaner Production*, vol. 69 (2014), 10–16.

[89] E.g. Taylor et al., 2015.

- LCD monitors and TVs witnessed a fall in lifespans by 17 percent, and other information technologies like PCs, laptops, and mobile phones by 10 percent; between 2000 and 2010 in the Netherlands.[90]
- Between 2000 and 2005, the lifespan of most domestic appliances and consumer electronics were in decline in the Netherlands, with CFL lamps the only exception.[91]
- According to a German study, the first useful service life of most electrical and electronic appliances has decreased from 14.1 years to 13.0 years between 2004 and 2012/13 for large household appliances.[92]
- The study also found that an increasing share of appliances are replaced or discarded before they reach the average first useful service life or at least five years of operation (an increase from 7 to 13 percent in the same period).[93] Moreover, the study indicated that the lifespan of electrical and electronic appliances is becoming shorter, with the share of appliances being replaced within five years due to defects showing an increase from 3.5 percent in 2004 to 8.3 per cent in 2013.
- A lot of products found at collection points or recycling centres in 2013 were just five years old or less, much lower than the expected average lifetime.[94] The reason for this includes:[95] 1) cheap, low-quality products may have components that break down early, and consumers do not think it is a good decision to invest in repairs, and 2) consumer switch products before they break down for other reasons. Further, interviews with Producer Responsibility Organizations also reveal that some products could have lived much longer if consumers had performed some service: often, they only need a proper service to function again.[96]

Premature obsolescence can be "planned" (i.e. intentional), but this is rare, although there are several documented examples.[97] A recent potential "planned" case concerns batteries in electric bikes.[98] However, in many cases it is hard – also for experts – to conclude whether obsolescence is planned or not.[99]

There are three key strategies that manufacturers can make use of to stimulate repetitive consumption:[100] 1) the limitation of material or component durability; 2) lack of repairability and; 3) the psychological element of design.

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90 Huisman et al., *The Dutch WEEE flows*, 2012.

91 Wang et al., Enhancing E-waste estimates: improving data quality by multivariate input–output analysis, *Waste Management*, vol. 33 (2013), 2397–2407.

92 Prakash et al., *Einfluss der Nutzungsdauer von Produkten auf ihre Umweltwirkung: Schaffung einer Informationsgrundlage und Entwicklung von Strategien gegen Obsoleszenz*, 2016.

93 Ibid.

94 Ibid.

95 Stamminger et al., 2018.

96 This is based on interviews with a North European PRO, in February 2020, in the CREACE project. See also Dalhammar et al, 2020a.

97 Kahlin McVeigh et al., 2019.

98 Åslund, Batterier från Biltema dör, men kan väckas igen, *Allt om elcyklar*, 2019. https://alltomelcyklar.nu/nyheter/batterier-fran-biltema-dor-men-kan-vackas-igen/

99 Rampell, Planned Obsolescence, as Myth or Reality, *New York Times*, 2013.

100 Guiltinan, Creative Destruction and Destructive Creations: Environmental Ethics and Planned Obsolescence, *Journal of Business Ethics*, vol. 89 (2009), 19–28.

The main reasons for obsolescence include:[101]

- Product failure or breakdown (often due to specific components).
- System obsolescence – e.g. lack of software updates or support, or software updates that impede the functioning of the products.
- No access to – or expensive – spare parts for repairs.
- Repair services are expensive or inaccessible, or generally considered less desirable that buying a new product with a guarantee.
- Technological or functional obsolescence – "outdated products".
- Psychological or style obsolescence – obsolescence driven by marketing campaigns etc.

Current policy approaches are focusing on the first four categories above. It is usually difficult to address e.g. style obsolescence and functional obsolescence through policy.

As stated above, there are few cases of deliberate obsolescence. In an interview study with German designers, this was confirmed.[102] The designers argued that there is of course always a certain trade-off between e.g. material cost and product lifespan, but they all argued that they would prioritize longer lifespan over cutting costs; this was especially the case for more expensive brands. However, the designers all agreed that their products would not always meet the targeted lifespan. They provided three main reasons for this:

1. The first one is *the rising complexity of new products*: New features, more options, additional digital control with growing numbers of sensors etc., create interdependencies that are difficult to predict and overlook. Thus, the single components will in most cases be adequate to the requirements, but the system as a whole might lack 'stability'.[103]
2. The *increasing competition among companies for innovation leadership leads to a permanent pressure to reduce time to market*. Typically, it is the time budget, and not the technical skills of developers, that limits in-depth-mastery of endurance of components and interaction of sub-systems. Since traditional testing is often too time consuming, companies increasingly rely on short-cycle-testing and simulations. This limits the predictability of lifespans and functionality. Product recalls in the automotive sector is an example of the effects of this trend.
3. The third reason is *cost pressure*: Product prices are calculated through a 'top down' process, i.e. the marketing or the sales department explores which type of product, comprising a list of properties, that can be sold at a certain price. Then appropriate component prices and manufacturing costs are derived from this. This process limits the quality that is possible to obtain.

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101 E.g. Kahlin McVeigh et al., 2019.

102 Longmuss and Poppe, 2017.

103 This point was confirmed in an interview with a European OEM (white goods) in October 2020. The OEM representative however also claimed that designers/engineers are also responsible for the trend as they like to add new features to products, even if only a small minority of consumers actually are interested in these features.

The designers also expressed discontent with the current situation, as they would like to create better products. But product development processes under current (market) constraints means that each company has a very limited leeway in decision-making.[104] Thus, the problem is *systemic*.

General studies on barriers for ecodesign practices in companies also conclude that designers are 'locked in', by circumstances, and dependent on other company functions' 'buy-in' for ecodesign practices, and often also dependent on support by other actors in the supply chain.[105]

Interviews with producer responsibility organizations reveal that some brands are of higher quality than others, and therefore more popular as objects of reuse as second-hand products.[106] Generally speaking, some brands often sell more robust products than other brands. The economic case for remanufacturing and re-use are mainly found among products and components of high quality.[107]

Brands tend to differ both in terms of design, repairability and value as second-hand products. In the case of cell phones, there are indications that iPhones can be difficult and expensive to repair[108], but it is the most wanted brand on the second-hand market, which indicates that it has potential for a longer lifetime than many other brands.[109] Samsung's phones can be cheaper to repair than iPhones, which is also a good feature as a basis for longer lifetimes.[110]

3.2 Main barriers for repair

If a product breaks down, it does not have to be the end of its lifespan, as many products are repaired, either by the consumers themselves or repair shops. However, in many cases consumers choose not to repair broken devices. The choice to repair a broken device or not, is primarily a consumer decision, based on a number of factors, such as the possibilities to repair, the price and functionality comparison between the repair and a new purchase, the convenience and time, consumer needs, and fashions.[111]

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104 Unless they specifically choose to compete in a 'premium' market segment, cf. Miele. But this option is not open for all manufacturers.

105 E.g. Marwede et al., Hide and seek – a systemic approach to sustainability in product development, in *Product Lifetimes And The Environment 2019 Conference Proceedings*, 2019.

106 Interview with North European PRO, October 2020.

107 Frolov, *Reuse of white goods components – An interview study on drivers, barriers, and the future outlook*, 2020.

108 Svensson-Hoglund et al., 2021.

109 Makov et al., What Affects the Secondhand Value of Smartphones: Evidence from eBay. *Journal of Industrial Ecology*, vol. 23 (2019), 549–559.

110 Pehrsson, *Hållbara telefoner inom verksamheter: En studie om användandet av mobiltelefoner hos företag och hur valet av mobil kan ske med hänsyn till hållbarhet*, 2020.

111 There are a few, rare instances, when consumers are faced with some other options. For instance, in the case of a broken cell phone, the insurance company may require that the phone is sent in and considered for remanufacturing; then the consumer may get the same phone back, or receive money, depending on the potential to repair it. In the case of Sweden, cf. https://www.godsinlosen.se/home/om-oss/sahar-fungerar-det/

Consumers with a broken device are faced with four options:[112]

- contact the seller, the OEM's repair division or authorized repair service provider;
- approach a local, independent repairer;
- perform the repair themselves (DIY); or
- discard and replace the product.

There are many barriers for repair. A recent study reviewed the literature on barriers for repairs and summarized the identified barriers in four overall categories, as presented in table 6.[113]

Table 6. List of barriers for repair categorized by type of barrier.

Current Barriers for repair	
Socio-cultural	• Design preference for concealment of the functioning of devices and lack of knowledge on how products work. • Newness-fixation and high speed of design changes create perceived obsolescence, reducing consumer interest in repair. • "Maintenance lacks the glamour of innovation". • Material decay, due to lack of maintenance and repair is symptomatic of a devaluation of the present moment, in favour of the future promise of novelty. • Lack of time and attention. • Lack of ethics/morals of care and responsibility for one's biospheric impact. • Consumers lack economic and emotional attachment to products, leading to poor care and lower willingness to repair. • Lack of recognition (i.e. low social value of repair) makes repairers change career.
Economic	• Increasing presence of new, low-quality, low-cost product options. • OEM profit-orientation focused on higher-cost replacement and avoidance of cannibalized sales. • Consumers are "punished" for choosing to repair (instead of replacement) in the form of costs and inconvenience. • Repair perceived as risky. • Aftermarket profitability through monopolization for OEMs- "decoupling" consumer ownership in a manner that interferes with repair. • Lack of quality repair services.
Technical	• Convenience of disposal options. • Lack of repairability in product design. • Repair skills are neglected and devalued in formal design, technological and engineering education. • Lack of access to spare parts tools and other necessities. • Repair enabling continued (undesirable) use of lower-efficiency devices. • Safety and security issues stemming from non-expert/unsupervised repairs. • Manuals and repair information can be inaccessible for low-literacy repairers; translations to local languages and instruction videos are needed.

112 Deloitte et al., *Study on socioeconomic impacts of increased repairability*, 2016. Note: for more expensive goods, the consumer may also contact the insurance company.

113 This is an amended version of the table in Svensson-Höglund et al., A Future of Fixing: Upscaled Repair Activities envisioned using a Circular Economy Repair Society System Framework, presented at *Electronics Goes Green 2020 Conference*, 2020. Barriers are also taken from Svensson-Hoglund et al., 2021.

Current Barriers for repair	
Policy and Law	• Intellectual property laws (patents, copyright etc.) favouring incentives for innovation over repair, blocking repair. • Warranties and guarantees under Consumer Law are not enforced. • Contract law enforces repair restrictive clauses. • Lack of design laws towards more repairable products and accessible necessities for repair • Tax laws can make repairs less attractive (e.g. taxes on spare parts, or chemical taxes that must be paid by remanufacturers) • Rules on chemicals in products may pose barriers for repairs (e.g. if it is not possible to use old parts for repairs)

Among the most important barriers for repairs we find: current product design; the low cost of new products; OEMs that block independent repair services through software locks or the use of regulatory approaches to ban independent repairs or block access to reasonable prices spare parts (e.g. through contracts or IPR-related law), and the lack of access to high-quality repair services.[114] Also high costs for spare parts,[115] and the use of e.g. screws that block repairs are key barriers. Further, the fact that most product sales are linear and constitute traditional sales rather than selling functions/services, is a barrier as it means manufacturers have limited incentives to pursue 'design for durability' strategies.

Table 7. Reasons why people choose not to repair broken products.[116]

Contextual reasons	Repair is too expensive Repair is inconvenient (time, accessibility, information)
Product-related reasons	The EEE is not repairable (design) The terms of the guarantee are limiting (for instance, because the original guarantee is void if you repair the product, or because the guarantee on repairs provided by the repairer is too short)
Cultural reasons	Society rewards consumerism
Individual reasons	Lack of trust in repair services Negative past experiences with repair Preference for new products and lack of emotional connection (People that attach high importance to fashion and trends are not likely to engage in repair; products that are not emotionally important to people are not likely to be repaired) Electronics are co-owned (Products with shared ownership are less likely to be cared for and repaired than products with individual ownership)

[114] Dalhammar (ed.) and Richter (ed.), 2020.

[115] See e.g., Wrenn, Apple 'Added Authentication Chip' to iPhone 5 Cable to Stop Third-Parties Making Cheaper Versions (then Charges you £30 for its Own Adapter), *Daily Mail Online*, 2012. https://www.dailymail.co.uk/sciencetech/article-2208298/iPhone-5-Apple-adds-authentication-chip-charger-cable-stop-parties-making-cheaper-versions.html

[116] Dávila, *The role of the consumer in the transition to a circular economy: Incentivizing electronics repair*, 2021.

The most important barrier relates to the alternative to conducting repairs: new products are quite cheap, and come with a warranty, whereas the cost of repairs is expensive, and often uncertain. One problem with repairs is that consumers often have no idea what it will cost, and that many repairers charge a rather high sum just to look at the product. An OEM (white goods) interviewed in October 2020 stated that they have tried a 'fixed price' repair scheme for consumers, and that this increased the consumers' willingness to repair their products significantly. In such a scheme, all repairs cost the same. Sometimes this is beneficial for the repairer, and sometimes for the consumer. But it seems that consumers want certainty regarding the costs.

If consumers purchase expensive, high-quality products, the willingness to repair them, and invest in upgrades etc., increases significantly. This is both due to the economics (the product is a long-term investment) but also because consumers have probably invested 'emotionally' in the product.

3.3 Summarizing barriers for longer lifetimes and repairs

The main barriers for longer lifetimes and repairability are provided in Figure 2. It mainly focuses on issues that can be influenced by policies, such as product design and markets, less on 'cultural' issues.

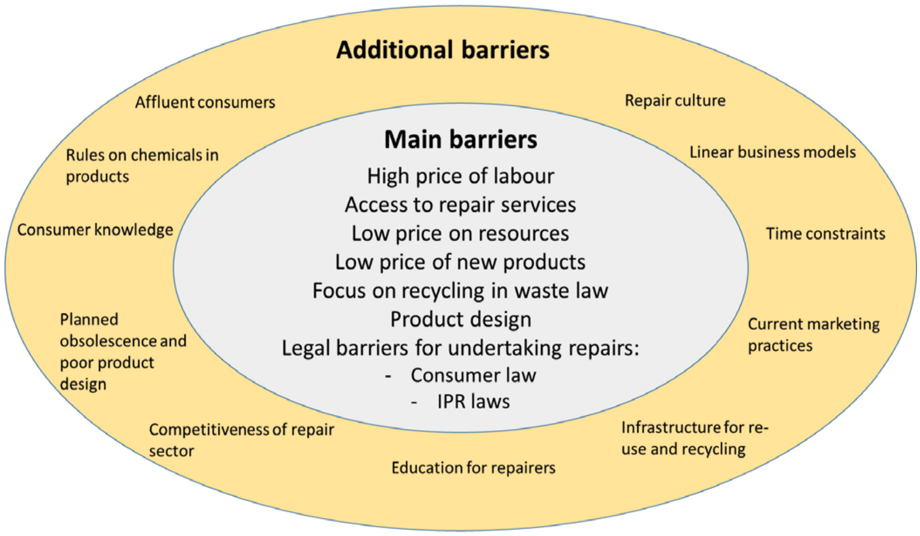

Figure 2. Summary of barriers for longer lifetimes and repairs.

The key issue in order to progress is to tackle the main barriers, but there could also be reasons to consider addressing the additional ones. For example, the repair sector is not very competitive (low profits), and many repair services do not aim to grow.[117] It could be relevant for governments to support education of repairers, but this mainly makes sense if the competitiveness concerns of the sector are also addressed, making repairs a more rewarding trade.

Further, the current focus on recycling in producer responsibility schemes is a barrier for re-use of products and components, as 1) collection for recycling is promoted, not re-use, and 2) a focus on recycling can pose a barrier for re-use practices if products are subject to rough treatment and rough weather.[118]

We will come back to the issue of a relevant policy mix to overcome these barriers in chapter 8.

[117] Dalhammar (ed.) and Richter (ed.), 2020.

[118] Dalhammar et al., 2020a; Frolov, 2020.

4 Approaches for measuring and regulating product lifespan and repairability

This chapter reviews how product lifetime and repairability can be measured, defined and regulated for various product groups, and the standards and ecodesign strategies that can support such developments. It also makes an inventory of adopted and proposed criteria under the Ecodesign Directive related to durability and repairability.

4.1 Standards to support measurement of product durability and repairability

There are numerous existing standards, or standards under development that could be used for circular economy purposes (cf. examples in Annex II). Further, there are specific needs for standard development in various sectors (cf. Annex III). Special attention has been given to certain standardization needs, such as standards for EV batteries (including 'second life' user applications) and plastics.[119]

In order to regulate or communicate durability and repairability, supporting standards are required.[120] Of special importance for this report is the European Commission's 2015 standardization request M/543 to the European Standardization Organizations CEN, CENELEC and ETSI.[121] The aim was to develop standards on material efficiency that could be used to support new future legal requirements for energy-related products, most notably those set under the Ecodesign Directive. Most of the deliverables requested under M/543 are not intended to be directly applied to a certain product group, but rather to be used as framework for the development of product-specific material efficiency standards by product-specific standardization groups.

Topics covered in the above standardization request are linked to the following material efficiency aspects of energy-related products:

- Extending product lifetime
- Ability to re-use components or recycle materials from products at end-of-life
- Use of re-used components and/or recycled materials in products.

The most relevant standards in the context of this report are outlined in table 8; our main focus in later sections in this chapter will be on the two first ones, namely EN 45552 and EN 45554.

119 See e.g. CEN-CENELEC, *Standardization in a Circular Economy – Closing the Loop*, 2020.

120 E.g. Tecchio et al., 2017.

121 See M/543 Commission Implementing Decision of 17.12.2015 on a standardization request to the European standardisation organisations as regards ecodesign requirements on material efficiency aspects for energy-related products in support of the implementation of Directive 2009/125/EC of the European Parliament and of the Council; Hughes, The EU Circular Economy Package – Life Cycle Thinking to Life Cycle Law? *Procedia CIRP*, vol. 61 (2017), 10–16; Schlegel et al., Ecodesign spinning towards the circular economy – the contribution of new standards on material efficiency. in *Product Lifetimes And The Environment 2019 Conference Proceedings*, 2019.

Table 8. List of European standards relevant for the durability and repairability of products.

Standard	Main purpose
EN 45552:2020 General method for the assessment of the durability of energy-related products.	Contains definitions of concepts like 'durability' and 'reliability' Provides a framework comprising of parameters and methods for assessing the reliability and durability of energy-related products.
EN 45554:2020 General methods for the assessment of the ability to repair, reuse and upgrade energy-related products	Defines parameters and methods relevant for assessing the ability to repair and reuse products; the ability to upgrade product (excluding remanufacturing); the ability to access or remove certain components, consumables or assemblies from products to facilitate repair, reuse or upgrade and; lastly by defining reusability indexes or criteria (supporting 'repairability scorecard').
EN 45556:2019 General method for assessing the proportion of reused components in energy-related products	Deals with the assessment of the proportion of reused components in energy-related products, on a generic level, which can be applied at any point in the life of the product.
EN 45553:2020 General method for the assessment of the ability to remanufacture energy-related products	Provides a general methodology for the assessment of the ability to re-manufacture energy related products. Elaborates on the assessment and process of re-manufacturability in a horizontal, cross-product way. However, product group-specific standards are needed to properly assess individual product groups.

Some authors argue that the new standards on material efficiency can be a 'game-changer' and support future ecodesign and labelling regulations[122]; other people we have talked to in industry and academia are less sure, stressing a number of barriers associated with regulating specific product groups. For example, that durability is complex concept and often includes several dimensions of functions. When it comes to repairability there are often trade-offs between criteria (see below and forthcoming chapters). There are other standards related to specific product groups that are also relevant for repair and re-use activities.[123] We will not discuss them in this report.

4.2 Measuring, communicating and regulating product durability and lifetime

4.2.1 Durability

Durability and lifetime can be measured using different parameters. Consumers tend to think of durability in numbers of years that a product functions, as this is what is included in legal and commercial warranties. The exception is cars, where distance (in kilometres) travelled are usually the key parameter rather than years in use. It would actually make sense to apply similar approaches to other products, e.g. estimating durability as the number of washes that a washing machine is expected to endure, rather than how many years it lasts, or how many hours in operation a vacuum cleaner will last. A first potential advantage with such parameters is that consumers would learn to make more accurate estimations of product functionality (for a washing machine, a guaranteed number of

122 E.g. Schlegel et al., 2019.

123 E.g. EN 50614 Requirements for the preparing for re-use of waste electrical and electronic equipment.

washing cycles is arguably a better reflection of product performance than a guarantee on how many years it will last). A second advantage is that many products (e.g. white goods) could then have – similar to cars – some kind of metering equipment so consumers would see how many cycles/hours in operation/etc. a product has run, providing additional incentives for manufacturers to invest in quality. Thirdly, such parameter (number of washes, hours in operation) have benefits for producers compared to a guarantee in years since it always carries the risk that some consumers may use the products extensively or inappropriately, and also works better for products used intensively (e.g. a vacuum cleaner used by a cleaning firm, which will obviously break down quicker that a vacuum cleaner used in a private household).[124]

It is also important to note that 'durability' for a product group may entail several dimensions. For advanced products like lighting products, several durability parameters can be relevant, such as 'numbers of hours in use with quality lumen output', 'colour consistency of light output over time' and 'number of switching cycles' (see more on this chapter 4.4.2). This complexity means that regulating durability requires use of different parameters and different testing methods for different product groups.

Often, durability tests are made for product components, and not the product in its entirety: it is typically the case that certain components that break down earlier than others and leads to product malfunction.

Increasingly, durability does not only relate to the product per se, but also its dependence upon software updates and the hardware-firmware-software interactions, as an increasing number of product groups will become 'smart' in the future. This is why 'software update' information is likely to be part of any future durability labelling scheme for some product groups. The same goes for access to spare parts. Also, in Ecodesign regulations, software issues are increasingly addressed. One example concerns the ecodesign requirements for electronic displays which addresses both 'circumvention and software updates' and 'availability of software and firmware updates'.[125]

4.2.2 Lifetime

When estimating lifetimes, various approaches are possible, e.g. whether we choose to measure the lifetime of a product (e.g. a cell phone) under its first user, or if we also include potential later users. A graphic representation of lifetimes is provided in Figure 3.

[124] Dalhammar, 2016.

[125] See Art. 6 and Annex II E, in Commission Regulation (EU) 2019/2021 of 1 October 2019 laying down ecodesign requirements for electronic displays pursuant to Directive 2009/125/EC of the European Parliament and of the Council, amending Commission Regulation (EC) No 1275/2008 and repealing Commission Regulation (EC) No 642/2009.

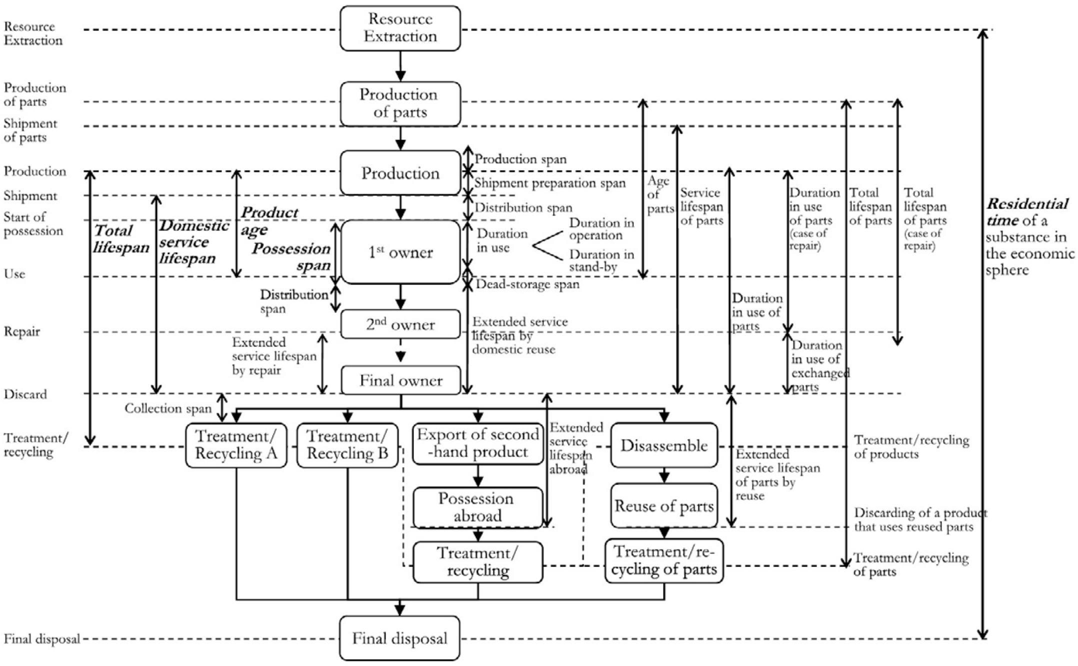

Figure 3. Definitions of various "life" terminologies for consumer durables and other machinery.[126]

The concepts found in the picture above are defined as follows:

- Age: The time span from the beginning of a product's life to the present (or the time of interest).
- Residential time: The duration of existence of the goods in question, such as materials or substances in our society, regardless of whether the goods still function.
- Service lifespan: This is defined in terms of goods or parts, not in terms of the owners. Service lifespan denotes the duration of the period when the goods function and can be put to use, including the duration of distribution for the next use. In the case of construction, this is often equal to total lifespan.
- Possession span: This denotes how long a consumer possesses the goods in question.
- Duration of use: This denotes how long a consumer uses the goods in question. Because it is defined for an owner, duration of use is different from the service lifespan. The difference between possession span and duration in use is the "dead storage period" – the duration of hibernation (e.g. cell phones or laptops that are no longer in use, being stored in homes).

[126] Murakami et al., Lifespan of Commodities, Part I: The Creation of a Database and Its Review, *Journal of Industrial Ecology*, vol. 14 (2010), 598–612.

Other important concepts, sometimes used in standards, include:[127]

- Technical lifetime/functional lifetime: The time period under which the product functions for its intended purpose: i.e., the total time period [during which] an asset/machine can technically perform/function before it must be replaced.
- Expected lifetime: The estimated technical lifetime. Can be applied for consumer redress purposes.
- Reference or estimated service life framework: Mainly used in construction as a reference for lifetimes.[128]
- Design life: The period of time during which the item (component or product) is expected – by its designers – to work within its specified parameters; in other words, the life expectancy of the item.
- Economic Life:[129] Economic life is the expected period of time during which an asset remains useful to the average owner. When an asset is no longer useful to its owner, then it is said to be past its economic life. The economic life of an asset could be different than its actual physical life. It may also differ from the depreciation[130] calculations used in accounting.

From a consumer perspective, lifetime can have different connotations, such as:[131]

- "Intended lifetime" represents how long consumers intend to use their products.
- "Ideal lifetime" represents the length of time for which consumers ideally expect the product to last. Ideal lifetime reflects the highest preference of consumers.
- "Predicted lifetime" represents the length of time for which consumers predict a product will last. Predicted lifetime reflects realistic predictions by consumers on the basis of their past experiences and other relevant factors.

4.2.3 New standardization developments

Of central importance for future regulations on durability is 'EN 45552:2020 General method for the assessment of the durability of energy related products', as the standard will be consulted in future ecodesign regulations and in various labelling schemes. The standard includes several important issues, including:

- Definitions of important concepts such as durability, reliability, intended use, wear-out failure, limiting state, primary, secondary and tertiary functions of a product etc.
- Information on the process of documenting the assessment of reliability and durability, and related data and information provision.
- Information on testing methods and data,[132] including information on accelerated testing and stress tests; some references are made to relevant standards.

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[127] E.g. Naturvårdsverket, *Produkters livslängd och återvinningsbarhet – översiktlig beskrivning av befintlig kunskap*, 2020.

[128] Cf. ISO 15686-1

[129] Chen, Economic Life, *Investopedia*, 2020. https://www.investopedia.com/terms/e/economic-life.asp

[130] Tuovila, Depreciation, *Investopedia*, 2020. https://www.investopedia.com/terms/d/depreciation.asp

[131] Oguchi et al., Consumers' expectations for product lifetimes of consumer durables, in *Conference Proceedings Electronics Goes Green 2016+ (EGG)*, 2016.

[132] E.g. testing of a physical sample and/or calculation from data, durability figures, test results for parts, handbooks or field data.

4.2.4 Policies for durability and lifetime

The table below provides examples of how durability and lifetimes of products and components are specified in various policies. Durability and lifetime are also regulated in ecodesign regulations, chapter 4.4.

Table 9. Examples of how durability and lifetimes of products and components are specified in various policies.

Case	Requirements and/or standards applied	Comments
Modulated fees, extended producer responsibility schemes in France[133]	**Textiles:** Producers benefit from a 75 % bonus if their products meet the criteria of dimensional stability (less than 5 %, ISO 5077 standard) and wash resistance of the dyeing process **Telephones:** 100 % extra fee if there is a lack of standardized connections, or lack of mutually compatible software updates, essential for basic use of the device	Some kinds of requirements require a supporting standard; others do not, as information provided by the manufacturer is used to show compliance. These fees have not had any significant effects on product design yet, but there are plans to raise the fees substantially in the near future.
Durability/ resistance of textiles	ISO 12945-2:2020. Textiles – Determination of fabric propensity to surface pilling, fuzzing or matting – Part 2: Modified Martindale method ISO 12947-2:2016. Textiles – Determination of the abrasion resistance of fabrics by the Martindale method – Part 2: Determination of specimen breakdown	
Examples of durability/lifetime requirements in the Nordic Swan ecolabel[134]	**Furniture and Fitments** (Version 4.11, 17 March 2011 – 30 June 2019): "Durability: Furniture textiles, i.e. textiles for seating, must have abrasive resistance corresponding to the rupture of the maximum of two threads at a minimum of 20,000 wear revolutions for domestic use and 40,000 for public use" **Toys** (Version 2.0, 21 March 2012 – 31 March 2016): "Colour retention: Colour retention at washing shall be at least level 3–4 for colour change and at least level 3–4 for discoloration. This requirement applies to washable textiles" **White Goods** (Version 5.2, 20 June 2013 – 31 December 2018): "The manufacturer is to provide a warranty that the white good will work for at least two years. The warranty is to apply from the day that the machine is delivered to the customer" **Windows and Exterior Doors** (Version 4.5, 19 March 2014 – 31 March 2020): "Guarantee: The window manufacturer must provide a 10-year guarantee covering function, insulating glass unit and wood rot. The guarantee must encompass all functional requirements in the applicable/relevant standards. The exterior door manufacturer must provide a 10-year guarantee for dimensional stability and a 2-year guarantee for function".	

133 Micheaux, *Le retour du commun au coeur de l'action collective. Le cas de la responsabilité élargie du producteur comme processus de responsabilisation et de co-régulation*, 2017.

134 Suikkanen and Nissinen, *Circular Economy and the Nordic Swan Ecolabel: An Analysis of Circularity in the Product-Group-Specific Environmental Criteria*, 2017.

Case	Requirements and/or standards applied	Comments
Examples of criteria, EU Ecolabel	**Textiles: Fitness for use** 17. Dimensional changes during washing and drying 18. Colour fastness to washing 22. Wash resistance of cleaning products 24. Fabric resistance to pilling and abrasion 25. Durability of function	Dec. 2014/350/EU: (EU Ecolabel for textile products) References to standards are provided for some criteria (e.g. ISO 12945-1 and ISO 12945-2)
	Televisions: 3. Life-time extension: The manufacturer shall offer a commercial guarantee to ensure that the television will function for at least two years. This guarantee shall be valid from the date of delivery to the customer. The availability of compatible electronic replacement parts shall be guaranteed for seven years from the time that production ceases. 4. Design for disassembly: The manufacturer shall demonstrate that the television can be easily dismantled by professionally trained recyclers using the tools usually available to them, for the purpose of: • undertaking repairs and replacements of worn-out parts, • upgrading older or obsolete parts, and • separating parts and materials, ultimately for recycling. To facilitate the dismantling: • Fixtures within the television shall allow for its disassembly, e.g. screws, snap-fixes…	Dec. 2009/300/EC: (EU Ecolabel for Televisions)
	Furniture: Various durability requirements for textiles and materials. Extended product guarantee: The applicant shall provide at no additional cost a minimum of a five year guarantees effective from the date of delivery of the product. This guarantee shall be provided without prejudice to the legal obligations of the manufacturer and seller under national law. Provision of spare parts: The furniture manufacturer shall make spare parts available to customers for a period of at least 5 years from the date of delivery of the product. The cost (if any) of spare parts shall be proportional to the total cost of the furniture product. Contact details that shall be used in order to arrange the delivery of spare parts shall be provided. Design for disassembly: For furniture consisting of multiple component parts/materials, the product shall be designed for disassembly with a view to facilitating repair, reuse and recycling. Simple and illustrated instructions regarding the disassembly and replacement of damaged component parts/materials shall be provided. Disassembly and replacement operations shall be capable of being carried out using common and basic manual tools and unskilled labour.	Dec. 2016/1332/EU (Ecolabel furniture) Assessment methods include use of standards, declarations, and technical drawings.
	Paints and varnishes: Various requirements related to durability and consistency	014/312/EU: (EU Ecolabel indoor and outdoor paints and varnishes)
TCO criteria[135]	Product lifetime extension: Product durability: drop and temperature resistance Battery life and replaceability Secure data removal Standardized connectors	Criteria are specific to each product category; thus, all criteria are not found in all categories (which include displays, notebooks, cell phones etc.)

135 https://tcocertified.com/criteria-overview/

4.3 Measuring and regulating repairability and upgradeability

4.3.1 The importance of ecodesign

Regarding *ecodesign*, some concepts are more closely related to design for repairability than others. The most important one is *design for disassembly, re-use and recovery*. Design for disassembly is a key issue for repairs as it affects the possibility for taking apart and fixing a product without harming it. Further, easy disassembly will reduce the time it takes to undertake repairs and thus also the cost of repairs. In the new EU Ecodesign requirements related to repairs, the EU has regulated this primarily through requirements for dismantling for material recovery, requiring that manufacturers, importers or authorized representatives shall ensure that products are designed in such a way that the key materials and components can be removed with the use of commonly available tools without damaging the product. They also specify that specific spare parts can be replaced with commonly available tools without permanent damage to the product.

In addition, *modular* product design can support repairs as it makes repair easier, and it can also support upgrading strategies for products. It is generally positive also for promoting other activities like remanufacturing and refurbishment. However, modularity may also entail drawbacks, and there can in some cases be a trade-off between modular flexibility and product performance.[136]

Of course, other design characteristics are related to repair as well. The indications are that the most important parameter for consumers considering repairs is the price of the products: the more expensive the product, the more likely it is to be repaired.[137] This also means that governmental policies and laws, or corporate strategies, which push the market to design more high-quality products, are also drivers of repairs. Further, the access to, and price of, spare parts is essential.

4.3.2 Measuring repairability and upgradeability

The main issues related to measuring repairability and upgradeability of products are discussed in-depth by Cordella et al.[138], and for a more detailed discussion on various issues and standards, we refer to that report. Cordella et al. propose a 'scoring framework' that can be used to assess the repairability and upgradability of products. For a given product group, they propose a 'hybrid' system that combines:

a) Pass/fail criteria that products have to fulfil in order to be eligible for the repair/upgrade rating.

b) A scoring framework based on scoring criteria, indicating to what extent/how much a product is repairable or upgradable.

[136] For more details see Amend et al., 2020.

[137] Dalhammar (ed.) and Richter (ed.), 2020.

[138] Cordella et al., *Analysis and development of a scoring system for repair and upgrade of products*, 2019.

They argue that a scoring framework inherently implies the presence of value choices and trade-offs between criteria.[139] However, they argue these should not come at the expenses of the actual possibility to repair/upgrade products, which is addressed through pass/fail criteria.

Such a scoring framework, applied to specific product groups, requires the definition of:

- Classification/rating criteria, to evaluate single parameters in relation to a set of priority parts.
- Appropriate assessment and verification procedures.
- An aggregation mechanism, to combine the scores achieved for each parameter and priority parts.

Cordella et al. further argue that, in order to ensure a level playing field, criteria should:

- Be measurable and enforceable in an objective way (i.e. not interpretable in different ways depending on who is doing the evaluation).
- Stimulate an active market for repair/upgrade (aiming to favour product options and scenarios that can result in an easier repair or upgrade operation), without undermining the product safety.
- Be adaptable to reflect specificities of groups/types of products.

The new European standard ‘General methods for the assessment of the ability to repair, reuse and upgrade energy related products’ (EN 45554:2020) was adopted after the report by Cordella et al.[140] was published. It provides a base for future regulations and labelling schemes on product repairability, as it provides a scorecard where different issues related to ‘product repairability’ can be assessed and weighted. The parameters include the ones provided in the table below.

Thus, based on the discussion in Cordella et al.[141], we could see future requirements on products related to upgradeability/repairability, assessed for each product group, where EN 45554:2020 could be used as basis for standards. However, the legal requirements and scorecard must be adapted for each individual product group, e.g. based on product characteristics and use aspects.

[139] One often discussed issue concerns using glue to make products – such as cell phones – more water-resistant and thus more durable. The water-resistance comes at the expense of ‘ease of disassembly’ and thus the product is more difficult to repair. What we should keep in mind is that not all trade-offs are genuine, in the sense that OEMs could probably both make the product more water-resistant and more easy to take apart, if they divert attention and resources to the issue. Quite often, there are more sustainable design solutions developed, but OEMs choose not to use them as they create additional (though quite small) costs. See e.g. speech by Joost Duflou, ‘Towards self-disassembling products’, at: https://www.youtube.com/watch?v=-MVrnn5hfug&feature=youtu.be

[140] Cordella et al., 2019.

[141] Cordella et al., 2019.

Table 10. Examples of criteria in repairability scorecard.[142]

Aspect	Examples
Design for disassembly	Fastener types
Tools and interface	Necessary tools required for repairs Diagnostic support and interfaces
Repair environment required	Workshop environment required for conducting repairs
Skill level	Skill level needed for conducting repairs
Software and data management influencing repair opportunities	Password and factory reset Data management
Return options for products	Available return options for repair, re-use or upgrade processes
Repair information	Availability for different actors (e.g. authorized and independent repairers, consumers) Comprehensiveness of information
Access to spare parts[143]	Duration (time) that spare parts will be available Spare parts interfaces Spare parts availability for different actors (e.g. authorized and independent repairers, consumers)

When the report was discussed in the Ecodesign and Energy Labelling Consultation Forum[144], it was concluded that the approach chosen could work in the EU legal context. The potential to turn the scorecard into categories, that could be communicated e.g. through the energy label or in some other way, was also discussed. For example, the classes could refer to what consumers could expect in terms of repairability:

- Level 1 (best) – Consumer should expect that defects can normally be repaired easily (e.g. by themselves, a handy family member or store employee)
- Level 2 – Consumer should expect that defects can usually be repaired, but it may cost some time/effort (e.g. product may need to be serviced by a professional or in a service centre)
- Level 3 – Consumer should be aware that defects can probably only be repaired/serviced by the original producer
- Level 4 – Consumer should be aware the product is unlikely to be reparable; any defects will probably result in discarding/replacing the product. [or product complying with Ecodesign requirement on reparability ‘a minima’]

4.3.3 Policies for repairability and upgradeability

The table below provides examples of how repair and upgradeability of products and components are currently specified in various policies. Repairability and upgradeability are also regulated in ecodesign regulations, chapter 4.4.

142 own illustration based on EN 45554:2020

143 Note that the RoHS Directive allows for the conditional use of spares that do not conform to the Directive. For more information see section 3.7 in Svensson-Hoglund et al., 2021.

144 Ecodesign and Energy Labelling Consultation Forum. N.D. Discussion note on the possible implementation of a Reparability Scoring.

Table 11. Examples of how repair and upgradeability of products and components are currently specified in various policies.

Case	Requirements and/or standards applied	Comments
Modulated fees, extended producer responsibility schemes in France[145]	Washing machines and dishwashers: Provision of essential parts for equipment use for 11 years provided with 20 % bonus Vacuum cleaners: an extra fee (malus) is charged if failure to provide technical documentation for authorized electrical repairers, or unavailability of essential spare parts Laptops: 20 % reduction of fee if product upgrade is possible w. standard tools	These fees have not had any significant effects on product design yet, but there are plans to raise the fees substantially in the near future.
Examples of durability & lifetime requirements in the Nordic Swan ecolabel[146]	TVs and projectors (Version 5.5, 20 June 2013 – 30 June 2020): "Requirements regarding life-time extension: The manufacturer shall offer a commercial guarantee to ensure … The availability of compatible electronic replacement parts shall be guaranteed for seven years from the time that production ceases" Computers (Version 7.4, 23 October 2013 – 30 June 2020): A computer must fulfil … following: "are easy to upgrade, dismantle and recycle". In addition: "Upgradeability: A category A, B, D or F computer must be modular. The user shall be able to replace the modules without the use of special tools and it shall be possible to upgrade the computer by primary memory expansion installation, exchange and expansion of mass storage, installation and/or exchange of CD ROM, DVD and hard disk drive, at least one additional interface for external storage media and other peripheral devices"	
TCO criteria[147]	Product lifetime extension: Battery life and replaceability Availability of replacement parts and service manuals	Criteria are specific to each product category

4.4 Recent Ecodesign Regulations related to lifetime and repairability

The Ecodesign Directive is usually considered to be the main policy instrument for regulating product lifetime and repairability[148], and it therefore has a prominent role in the EU Circular Economy Action Plan, as a tool for stimulating more 'circular' products.[149] Therefore, we will outline here some adopted and proposed Regulations under the Ecodesign Directive that are of relevance for product durability and repairability.

145 Micheaux, 2017.

146 Suikkanen and Nissinen, 2017.

147 https://tcocertified.com/criteria-overview/

148 The Directive applies to energy-related products. There is however not yet any EU law that aims to address other types of products like textiles and furniture. There is currently an ongoing process to revise the Directive, the Sustainable product initiative; read more at https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12567-Sustainable-products-initiative

149 Cf. COM(2020) 98 final.

4.4.1 Vacuum cleaners

In the 2009 consultancy study[150] for vacuum cleaners, the issue of durability was considered to be complex. As vacuum cleaners are only used for a very limited part of the lifetime, durability requirements were very relevant.[151] But there were vacuum models with poor performance on the market, and the optimal approach was considered to be the pushing of durability, but not until the worst performers had been removed from the market. The consultants stated: '... *we conclude that the issue of product durability should be considered after the proposed measures have been put into place and older less efficient vacuum cleaners have disappeared from the working EU stock*'.[152]

Therefore, the rules of durability of motors and hoses did not enter into force in the 1st tier (2014), but in the 2nd tier (2017). The main reason for regulating motors/hoses was that they are the most common cause of product malfunctioning. The requirements are formulated as follows[153]:

- the hose, if any, shall be durable so that it is still useable after 40,000 oscillations under strain;
- operational motor lifetime shall be greater than or equal to 500 hours.

The measurement and calculation methods applied are:

"7. Durability of the hose: The hose shall be considered useable after 40 000 oscillations under strain if it is not visibly damaged after those oscillations. Strain shall be applied by means of a weight of 2,5 kilogram."

"8. Operational motor lifetime: The vacuum cleaner shall run with a half-loaded dust receptacle intermittently with periods of 14 minutes and 30 seconds on and 30 seconds off. Dust receptacle and filters shall be replaced at appropriate time intervals. The test may be discontinued after 500 hours and shall be discontinued after 600 hours. The total run-time shall be recorded and included in the technical documentation. Air flow, vacuum and input power shall be determined at appropriate intervals and values shall, along with the operational motor lifetime, be included in the technical documentation."

4.4.2 Durability requirements for lighting

In a 2009 consultancy study[154] on lighting, it was clear that a long lifetime was positive both for reducing environmental impacts and from a consumer cost perspective. There have also been studies on 'optimal' lifetimes.[155] However, the issue of lifetime extension is much more complicated for lighting than for vacuum cleaners. This is because (i) lighting

[150] AEA Energy & Environment, *Work on Preparatory Studies for Ecodesign Requirements of EuPs (II) Lot 17 Vacuum Cleaners*, 2009

[151] It usually makes sense to prolong the lifetime on "inactive"/"passive! products; they are not using much energy, and thus replacing them with more energy-efficient models does not lead to significant energy savings.

[152] AEA Energy & Environment, 2019, p. 102.

[153] Regulation 666/2013/EU of 8 July 2013 Implementing Directive 2009/125/EC of the European Parliament and of the Council with Regard to Ecodesign Requirements for Vacuum Cleaners, [2013] OJ L192/24.

[154] VITO et al., *Lot 19: Domestic Lighting*, 2009.

[155] Richter et al., 2019b.

is a product group under rapid technological development, where LED lighting products have increased market share significantly in the last 10 years, and (ii) because durability is a concept that actually includes several dimensions in the case of lighting.

We typically think of the lamp lifetime as the time before a lamp stops functioning, but durability has more dimensions.[156] The lighting quality in terms of lumen (which measures luminous flux or luminous power, which is the measure of the perceived power of light) is also important. The lumen output of a lamp deteriorates during its lifetime, but not equally for all lamp types. The table below outlines some lifetime requirements for lamps adopted in a 2012 Ecodesign Regulation.[157]

Table 12. Durability requirements for lamps adopted in Regulation 1194/2012.

Requirements of EU Ecodesign regulations	Directional and LEDs	Non-directional lamps (italics for lamps excluding CFL and LEDs)
Lamp survival factor at 6,000 hours	≥ 70 % except LEDs ≥ 90 % LEDs	≥ 70 % ≥ 85 % at 75 % of rated average lifetime and 2000 hour minimum rated lifetime for lamps
Lumen maintenance' at 6,000 hours	≥ 70 CFLs ≥ 80 LEDs	≥ 85 % at 75 % of rated average lifetime
Number of switching cycles before failure	≥ 15,000 if rated lamp life ≥ 30,000 hours, otherwise ≥ half the rated lamp life expressed in hours	≥ lamp lifetime expressed in hours ≥ 30 000 if lamp starting time > 0.3 s ≥ four times the rated lamp life expressed in hours
Premature failure rate (maximum number of failure products in %)	≤ 5 % at 1 000 h	≤ 2 % at 400 h ≤ 5 % at 200 h
'Colour rendering' requirements for various applications	≥ 80	≥ 80

Thus, 'durability' is a multidimensional issue in the context of lamps and include criteria like premature failure rate and colour consistency. The lamp durability is not only dependent on design but also on issues like the number of switching cycles.

The 3 previous ecodesign regulations for lamps have now been replaced by a single regulation;[158] most of the requirements entered into force in September 2021. It also includes some durability requirements under its functional requirements (Table 13).

156 E.g. Narendran et al., Projecting LED product life based on application, in *Proceedings Volume 9954, Fifteenth International Conference on Solid State Lighting and LED-based Illumination Systems*, 2016. https://doi.org/10.1117/12.2240464; Richter et al., 2019b.

157 Cf. Regulation 1194/2012 of 12 Dec 2012 Implementing Directive 2009/12/EC of the European Parliament and of the Council with Regard to Ecodesign Requirements for Directional Lamps, Light Emitting Diode Lamps and Related Equipment, [2012] OJ L342/1, Annex II.

158 Commission Regulation (EU) 2019/2020 of 1 October 2019 laying down ecodesign requirements for light sources and separate control gears pursuant to Directive 2009/125/EC of the European Parliament and of the Council and repealing Commission Regulations (EC) No 44/2009, (EC) No 245/2009 and (EU) No 1194/2012.

Table 13. Functional requirements for light sources according to Commission Regulation (EU) 2019/2020.

Colour rendering	CRI ≥ 80 (except for HID with Φ_{use} > 4 klm and for light sources intended for use in outdoor applications, industrial applications or other applications where lighting standards allow a CRI< 80, when a clear indication to this effect is shown on the light source packaging and in all relevant printed and electronic documentation.
Displacement factor (DF, cos φ_1) at power input P_{on} for LED and OLED MLS	No limit at P_{on} ≤ 5 W, DF ≥ 0,5 at 5 W < P_{on} ≤ 10 W, DF ≥ 0,7 at 10 W < P_{on} ≤ 25 W, DF ≥ 0,9 at 25 W
Lumen maintenance factor for LED and OLED	The lumen maintenance factor X_{LMF}% after endurance testing according to Annex V shall be at least $X_{LMF,MIN}$ % calculated as follows: $X_{LMF,MIN}\% = 100 \times e^{\frac{(3000 \times \ln(0.7))}{L70}}$ where L_{70} is the declared $L_{70}B_{50}$ lifetime (in hours) If the calculated value for $X_{LMF,MIN}$ exceeds 96,0 %, an $X_{LMF,MIN}$ value of 96,0 % shall be used
Survival factor for LED and OLE	Light sources should be operational as specified in row 'Survival factor (for LED and OLED)' of Annex IV, Table 6, following the endurance testing given in Annex V.
Colour consistency for LED and OLED light sources	Variation of chromaticity coordinates within a six-step MacAdam ellipse or less
Flicker for LED and OLED MLS	P_{st} LM ≤ 1,0 at full-load
Stroboscopic effect for LED and OLED MLS	SVM ≤ 0,9 at full-load (except for light sources intended for use in outdoor applications, industrial applications or other applications where lighting standards allow a CRI < 80) From 1 September 2023: SVM ≤ 0,4 at full-load (except for light sources intended for use in outdoor applications, industrial applications or other applications where lighting standards allow a CRI < 80)

The long lifetime LED lamps makes it impractical test them in real-life conditions, and durability testing will therefore need to make use of some kinds of stress tests.

It would make sense to adopt regulations on lifespan for lamps once LED lamps are becoming more mature: when the energy efficiency is so high that it is hard to improve it, the lamps could be more durable in order to save resources. But several aspects – including the problems in testing the lifespan of products, and potential implications of future software in lamps – means that it is not a given that this should be promoted through the Ecodesign regulation. Other policies may be used instead, for instance, in B2B transactions and public procurement, long commercial warranties and service contracts could be applied.[159]

4.4.3 New Ecodesign regulations October 2019

Apart from the regulation on lighting products from September 2021 (above), nine other ecodesign regulations were adopted in October 2019. They include a number of consumer and B2B products, and the European Commission announced that this

159 Cf. Richter et al., 2019b.

was the first generation of Ecodesign policies that specifically took circular economy perspectives into account in a more systematic way.[160] Most of these regulations have various criteria that relate to lifetime and repairs, in various ways. In the table below we provide example of 'typical' criteria that are related to durability/lifespan/repairability/upgradeability; for more details on these criteria for each product group, see Annex IV.

Table 14. List of products under the new EU Ecodesign Regulations[161] and some examples of criteria applied relevant to the circular economy.

Product groups	Examples of criteria applied
Refrigerators, electronic displays, washing machines, washer-dryers dishwashers, refrigerating appliances with a direct sales function, welding equipment	**Spare parts:** • Making key spare parts available for all repairers • Maximum delivery time for spare parts • Replacing spare parts possible with commonly available tools • Obligation to provide information on e.g. a) access to professional repair, ordering spare parts, minimum duration of producer guarantee, and minimum period under which key spare parts are available • Information on (some of) the above should be publicly available **Information:** • Making repair and maintenance information available to qualified repairers • Information on availability of software and firmware updates (for some products groups) • Making software updates available for a minimum number of years, at no, or limited, cost **Dismantling:** • Product design: dismantling of key components and materials should be possible with commonly available tools

Generally, the criteria address the 'repairability' issues related to products, rather than the 'lifespan' per se. And typically, the direct criteria on design relate to 1) design for dismantling (key components) and 2) design that allows dismantling/repair with commonly available tools. Thus, it is rare that product lifespan is regulated directly, e.g. with a minimum lifetime expressed in e.g. hours.

160 Cf. European Commission, *The new ecodesign measures explained*, 2019. https://ec.europa.eu/commission/presscorner/detail/en/QANDA_19_5889

161 Ibid.

4.4.4 Proposed ecodesign standards for batteries

A consultancy report with proposed ecodesign requirements were published in August 2019.[162] Among proposed ecodesign requirements were: 1) minimum battery pack/system lifetime requirements, including minimum battery pack/system warranty per product; 2) requirements for battery management systems with partially open data (e.g. in order to reduce repair costs and support remanufacturing), and; 3) requirements for providing information about batteries and cells (in order to support repair, reuse, remanufacturing, repurposing and recycling of batteries).

The Commission recently launched a proposal for a Battery Regulation, not under the Ecodesign Directive but as an independent Regulation on batteries.[163] The proposal discusses the potential to set requirements such as:

- Information requirements on performance and durability.
- Minimum performance and durability requirements for certain batteries as a condition for placement on the market.
- How to promote and classify repurposed batteries.
- Requirements that manufacturers shall design appliances, in which portable batteries are incorporated, in such a way that waste batteries can be readily removed and replaced by the end-user or by independent operators.

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[162] VITO et al., *Preparatory Study on Ecodesign and Energy Labelling of rechargeable electrochemical batteries with internal storage*, 2019.

[163] COM(2020) 798/3, Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020. The Regulation would repeal Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators.

5 Product policy conflicts in the circular economy

This chapter provides a brief overview of conflicting product policies in the context of the circular economy.

5.1 Policy synergies and policy 'conflicts' in the area of product policy

The product policy mix in the EU is growing, due to new policies adopted at both the EU and national levels. This can be considered positive from a sustainability perspective, as it provides more incentives for sustainable products. But the sheer complexity of the policy mix means that we need to carefully consider the interaction of policies.

Table 15. The variety of policies addressing several aspects of products.[164]

Environmental aspect	Examples of European Union laws and policies	Examples of Member State policies
Chemical and material content	Horizontal legislation (e.g. REACH) Rules related to conflict minerals use and traceability Sector oriented laws on chemical restrictions (e.g. packaging, electronics, toys) EU Ecolabel	Green public procurement (GPP) criteria for e.g., chemicals and conflict minerals in goods, or procuring bio-based products Ecolabels Taxes on chemicals
Collection and recycling of waste products	General rules and guidelines (e.g., Waste Framework Directive) Sector oriented EPR laws (e.g. WEEE Directive; Waste and Packaging Waste Directive)	Waste related taxes Infrastructure for re-use & recycling Re-use parks/supporting shops for re-used products/repair activities Mandatory re-use obligations for white goods (Spain)
Energy efficiency	Mandatory energy performance regulations (set under the Ecodesign Directive) Mandatory energy labelling (set under the Energy Labelling Directive) Energy performance requirements for buildings Voluntary labelling (EU Ecolabel)	Green public procurement criteria The use of life cycle costing (LCC) GPP Promoting energy efficient products through public procurement LEED and other certification schemes for buildings Ecolabels

[164] Dalhammar et al., Ecodesign and the Circular Economy: Conflicting Policies in Europe, in *EcoDesign and Sustainability: Products, Services, and Business Models*, 2020b.

Environmental aspect	Examples of European Union laws and policies	Examples of Member State policies
Durability, lifetime, resource savings, and repairability	**Direct incentives:** Mandatory lifetime requirements set under the Ecodesign Directive for vacuum cleaners & lighting products Mandatory regulations under the Ecodesign Directive supporting disassembly & repairs (several product groups) Proposal: providing information about expected lifetime to consumers through mandatory information scheme Voluntary agreements under the Ecodesign directive, e.g. for imaging equipment (e.g. duplex printing as standard) **Indirect incentives:** Minimum rules on consumer guarantees Development of standards for e.g. durability, remanufacturing, re-use among European Standardization bodies	**Direct incentives:** Banning planned obsolescence (France) National/regional ecolabels sometimes include criteria related to product maintenance, and access to repairs and spareparts; and quality testing etc. Modulated fees in EPR **Indirect incentives:** Incentivizing the provision of spare parts (France) National rules on longer consumer guarantees and/or changed rules for burden of proof is transferred from seller to consumer (several EU Member States) Right-to-repair laws (US) Lower VAT on repair services (e.g. Sweden) Public procurement of remanufactured furniture and computers (e.g. Sweden)

Clearly some policies have ‘synergistic’ effects, i.e. they work well together. But there is an increasing recognition that some policies may be in conflict with each other, and in literature there is an increasing number of examples of such conflicts (see table 16 and chapter 5.6). Thus, issues related to ‘policy coordination’, ‘policy integration’ and ‘policy harmonization’ are of increasing importance.

Table 16. Definition of policy concepts.[165]

Legal/policy harmonization	The process of creating common standards among countries or regions. Harmonization aims to 1) create consistency of laws, regulations, standards and practices, so that the same rules will apply to businesses; and 2) reduce compliance and regulatory burdens for businesses operating nationally or transnationally.
Positive harmonization (in the EU)	National laws and policies are replaced by common EU rules and policies.
Negative harmonization, e.g. in the EU and related to the WTO agreements	National laws and policies are not allowed as they are in conflict with EU rules or international agreements
Coordination of laws and policies	While harmonization aims to create common standards, coordination rather accepts that there are different rules or policies, and instead aim to make these interact as smoothly as possible.
Policy integration	This concept has many different understandings. We define it as the process of identifying and addressing synergies and trade-offs between various public policies.
Regulatory overlap	Different laws regulate the same issues (e.g. the same type of product or the same life cycle phase in the product life cycle); it can also be that different legal fields (e.g. environmental law vs. corporate law) regulate the same issue. The laws can be in conflict or contradict each other, or work in synergy and complement each other.
Conflicting objectives	Different laws and policies have conflicting aims.
Conflicting rules and procedures	The aims of different laws and policies may not conflict, but the rules will conflict in practice. For instance, while one law may promote recycling, other rules on levels of chemicals in products may mean that producers do not want to make use of recycled materials in their products as they fear being in breach on these rules.
Sequential issues	The sequencing may matter and influence whether rules are complementary or conflicting. For instance, rules that restrict chemicals in products will improve future recycling, as it improves both recycling processes and the health and safety of the recycling environment. However, in the short-term stringent rules on chemicals may mean that producers do not want to make use of recycled materials in their products as they fear being in breach on these rules; this undermines the economic case for recycling.

Regarding harmonization, we will come back to this issue in chapter 8, as an effective policy mix for longer lifetimes and repairs entails both a) policies that must be harmonized at the EU level, and b) national policies.

[165] Ibid.

5.2 Examples of conflicts

There is an increasing number of studies that look at policy conflicts in the Circular Economy.[166]

Conflicts can emerge at several levels/scales:

- **The Circular Economy and policies outside the environmental area:** Policy objectives in the circular economy can be in conflict with various rules. For instance, current EU consumer law does not primarily promote repair as a way to redress faulty products; instead producers and consumer often opt to replace them with new products.[167] Likewise, intellectual property rules can be used by manufacturers to inhibit consumers' options for repairing their products.[168]
- **Conflict between the EU regulatory frameworks for products, waste and chemicals:** There is an inherent conflict between these policies, as noted by the Commission[169] and academics.[170] The most crucial one concerns the conflict between the policy objective to increase recycling levels and the objective for toxic-free material streams, which in turn hinders the use of recycled material in products. In some cases, compromises can be made, but in some cases, we may need to make material streams "purer" before we can recycle materials.
- **Trade-offs between environmental objectives when applying specific policies:** Sometimes trade-offs are inevitable when applying policy instruments. For instance, buying reconditioned furniture can be a good deal for the public sector as the price is much lower than for new furniture, and procuring reconditioned furniture can also save a lot of resources compared to procuring new ones. However, procuring reconditioned furniture has proven to be far from straightforward in practice. A first problem is that reconditioned furniture may be good for the environment, but purchasing them may mean that other sustainability criteria may have to be compromised.[171] This is because the public sector has a lot of criteria that relate to e.g. chemical content and sustainable sourcing of raw materials (e.g. FSC certified wood). These requirements can be put on new furniture as the relevant information to prove compliance with such criteria is usually available. This is typically not the case for older, reconditioned furniture, and thus purchasing such furniture requires that other criteria are compromised.

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166 Dalhammar et al., 2020b; Technopolis Group, 2016.

167 Maitre-Ekern and Dalhammar, 2019. In Dir. 2019/771, the EU has chosen to address this issue through provision that allows a consumer to require repairs of faulty products even when sellers would like to replace it with a new product. But, the consumer can still choose the option of getting a new product.

168 Svensson-Hoglund et al., 2021.

169 COM(2018) 32 final.

170 Wagner and Schlummer, Legacy additives in a circular economy of plastics: Current dilemma, policy analysis, and emerging countermeasures, *Resources, Conservation and Recycling*, vol. 158 (2020), 104800; Sevelius, *Ökad plaståtervinningvs giftfria materialflöden – En analys av ändringen av POPs-förordningen*, 2019; Kristoffersson, *Effekter av den svenska skatten på kemikalier i viss elektronik*, 2019; Dalhammar et al., 2020b; Alaranta et al., How to Reach a Safe Circular Economy? – Perspectives on Reconciling the Waste, Product and Chemicals Regulation, *Journal of Environmental Law*, 2020. doi: https://doi.org/10.1093/jel/eqaa016

171 Öhgren, *Upphandling av rekonditionerade kontorsmöbler – En strategi för att stärka utvecklingen mot en cirkulärekonomi*, 2017.

An alternative solution is to design a procurement process that sets two contracts: one for new furniture and one for remanufactured furniture. This is however administratively complex, and thus shows the importance of flexibility and innovation in procurement processes to allow innovative solutions.

- **Circular economy policies may be context-dependent:** Sometimes, the "optimal" policy standard depend on the context, as will be discussed also in the next chapter. For instance, it makes more sense to promote durable products for "mature" technologies, as the trade-off between longer lifetimes (which saves resources) and energy/climate objectives (switching earlier to newer products that is more energy-efficient) is then quite small. Further, it may make more sense to promote resource-related objectives in a country with a high share of renewables in the electricity mix (e.g. Norway), but more relevant to promote climate-related objectives in a country where the electricity mix is mainly fossil-based (e.g. Poland) (see also next chapter).
- **Sub-optimization problems and dynamic elements:** The traditional idea of the main environmental impacts of a product or a building may lead to sub-optimization if certain conditions change. One well-known example concerns embodied carbon in buildings.[172] In the building life cycle embodied carbon is the carbon dioxide equivalent ($CO2_e$) or greenhouse gas (GHG) emissions associated with the non-operational phase of the project, e g: extraction, manufacture, transportation, assembly, maintenance, replacement, deconstruction, disposal and end of life aspects of the materials and systems that make up a building. As we build increasingly energy efficient buildings, and make use of more renewable energy, the proportion of the building's lifecycle carbon that comes from the embodied carbon becomes more significant. Thus, optimizing energy use in the operational phase may no longer be the most viable strategy to save carbon, and we need to switch focus to embodied carbon. We have seen the same developments related to the Ecodesign Directive: 10 years ago, the common wisdom was that 'energy in the use phase' had the highest environmental impact for virtually all product groups. Today, we can see how this perception has changed e.g. in the case of consumer electronics. From a policy-making perspective, it is important to consider dynamic issues: LCA methodologies, and CBAs, tend to be used in a quite 'static' way, and often the results are considered to be 'truths'. But as the market reacts to changes induced e.g. by policies and consumer culture, it is important that we apply a dynamic perspective also in policymaking.

More information about life cycle impacts and potential trade-offs are provided in the next chapter.

[172] Giddings and Lomas, Why we need embodied carbon regulation now, *Architect's Journal*, 2020. https://www.architectsjournal.co.uk/news/opinion/%E2%80%8Bwhy-we-need-embodied-carbon-regulation-now; Wretlind, *Embodied Carbon in Buildings – Investigating drivers and barriers for the Swedish construction industry to address Embodied Carbon, and necessary policy support as deemed by the industry*, 2015.

6 Prolonging the lifetime of products: environmental impacts and trade-offs

This chapter gives an overview of environmental benefits and trade-offs with prolonging the lifetime of products.

6.1 Prolonging lifetime of products

When products reach the end of their lifetime, they are most often replaced with new products that require materials and energy to produce. Extending the lifetime of products reduces the rate at which products must be replaced, slowing down material and product cycles and potentially resulting in decreased energy and material consumption. This decreased impact potential is highly dependent on key factors related to the product itself, product development over time, consumer behaviour and lifetime extension strategies applied.

6.1.1 Assessment of environmental impacts

Life cycle assessments (LCAs) are often used to analyse the potential benefits and negative environmental impacts from products. In many LCAs, however, lifetime is treated as a static variable. Even when sensitivity analyses are applied, often the assumptions of a shorter lifetime are that a product would be replaced with an identical product, in which case longer products lifetimes are always found to be preferred. However, such LCAs fail to consider product developments and other important factors that can affect this question significantly.[173]

The impacts of durability and prolonging product lifetimes should be assessed through scenarios that consider key variables.[174] Key variables of such scenarios include:

- assumptions about the product (e.g. average lifetime or usage duration, energy efficiency)
- assumptions about the use stage (e.g. intensity of use, other consumer behaviours)
- the system boundaries (i.e. what is included with the product itself, e.g. drying as well as washing), and overlaps between product systems (e.g. clothes, detergents, washing machines)
- which impacts are considered (e.g. climate impacts, resource depletion, toxicity, etc.)

[173] Richter, *Towards a Circular Economy with Environmental Product Policy: Considering dynamics in closing and slowing material loops for lighting products*, 2019.

[174] Ardente and Mathieux, Environmental assessment of the durability of energy-using products: Method and application. *Journal of Cleaner Production*, vol. 74 (2014), 62–73; Boldoczki et al., The environmental impacts of preparation for reuse: A case study of WEEE reuse in Germany. *Journal of Cleaner Production*, vol. 252 (2020), 119736; Proske and Finkbeiner, Obsolescence in LCA–methodological challenges and solution approaches. *The International Journal of Life Cycle Assessment*, vol. 25 (2020), 495–507.

- which product improvements are considered (e.g. only energy, or also improved materials?)
- the rate of product improvements (this also influences how long the results are valid)
- the life extension strategy applied (e.g. durability, small repair, etc.)

While the variables considered apply to any product, assessments themselves consider the variables for different products and include sensitivity analysis on less certain variables (e.g. those related to product developments). In addition, it is also necessary to consider the context in which the product is used.[175]

6.1.2 *Prolonging lifetimes for different types of products*

For some products, the benefits of prolonging lifetimes are clear. Prolonging lifetimes is generally preferred for non-energy using products with high extraction and production stage impacts compared to other life cycle stages. However, for some products, particularly energy-using products with high impacts in the use stage, prolonging lifetimes (i.e. prolonging the use stage) can come with trade-offs. While much of LCA research investigates whether a longer lifetime results in less environmental impacts, some LCA research seek to find the *optimal* lifetime by identifying "the time when the environmental impacts that arise from using a product equal the embedded impacts of a (more energy efficient) replacement product." [176] The *optimal* lifetime of a product can be difficult to determine in practice, as this can be subject not only to the variables outlined above, but also to consumer factors and larger market trends.

The following sections give an overview of LCA research of assumed lifetimes, the impact of longer lifetimes, and considerations of optimal lifetimes for different case products found in literature. Many products have been modelled by LCA research for many years resulting in a multitude of studies. This overview gives priority to studies that 1) best adhere to incorporating the variables outlined above, 2) are more recent and consider the latest product developments, and 3) present a key lesson for consideration of longer product lifetimes.

Refrigerators

A study by Wang et al. of consumer durables use, found that refrigerators in 2005 were used on average for 14 years.[177] A Japanese study[178] of optimal lifetimes in the context of more energy efficient replacement products, indicated an optimal lifetime of 8–10 years, even if the replacement product was 100 litres larger. However, with product developments maturing, Bakker et al.[179] showed, with UK data, that the optimal lifetimes of refrigerators bought in 2001 was 10 years but refrigerators bought in 2011 was 20 years, as improving energy efficiency of the base products also mattered, as well as the anticipated future improvements; i.e. the lower expected energy efficiency in the future, the more the lifetime matters.

[175] Richter, 2019.

[176] Bakker at al., 2014.

[177] Wang et al., 2013.

[178] Tasaki et al., Assessing the replacement of electrical home appliances for the environment: An aid to consumer decision making. *Journal of Industrial Ecology*, vol. 17 (2013), 290–298.

[179] Bakker et al., 2014.

In considering longer product lifetimes, more durable products may also entail additional materials in the design. For example, a study of durable versus standard refrigerator scenarios[180] assumed a 10 % increase in copper content for a more durable cooling system in a longer life refrigerator. That study found that replacing a refrigerator with a 10 % more energy efficient model was preferable to a durable model for most environmental impacts considered, with the exception of impacts stemming from the production or end-of-life phase. These impacts, which include ozone depletion, human toxicity, fresh-water ecotoxicity, and mineral, fossil and renewable resource depletion, were always less with the durable model.

In a study comparing scenarios of recycling versus reusing refrigerators, Baxter[181] found that the optimal lifetime is also highly dependent on the electricity mix where the refrigerator is used. In the EU average electricity mix, recycling was preferred for most environmental indicators around 7 years while in the Norwegian electricity mix the modelling showed that reuse and/or remanufacturing are preferred with optimal lifetimes extending beyond 20 years.

Electric Ovens

A study looking at durability of ovens used a baseline lifetime of 10 years compared to durable option of 15 years, considering different product models from literature and producer data.[182] The findings indicate that for most energy and climate impacts an energy-efficiency improvement of around 15 % was sufficient for the standard product (i.e. 10 years) to be preferred over the durable product (i.e. 15 years) and that this rate of energy efficiency improvement could be expected by moving one energy class (e.g. B to C) for ovens. The study also found that for the impact categories whose significant contribution comes from the production and end of life phase (i.e. human toxicity, fresh-water ecotoxicity; mineral, fossil and renewable resource depletion), the "durable" option performs better than the "standard" option, even if there are improvements in the energy efficiency.

Lastly, the study of ovens found that when data from the producer was used, rather than data from literature, the "durable" option had lower environmental impacts in more (ten) impact categories. The study found that the literature assumed higher energy efficiencies for products than the producer data. This highlights the importance of data and assumptions about energy efficiency of products.

Washing Machines

The average lifetime for washing machines in the EU ecodesign preparatory studies to be 12.5 years.[183] The use phase of a washing machine is the most significant contributor to environmental impacts such as cumulative energy demand (~ 80 %), global warming potential (84 %), and water use, while impact categories dependent on resource depletion

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180 Boulos et al., 2015.

181 Baxter, Systematic environmental assessment of end-of-life pathways for domestic refrigerators. *Journal of Cleaner Production*, vol. 208 (2019), 612–620.

182 Iraldo et al., Is product durability better for environment and for economic efficiency? A comparative assessment applying LCA and LCC to two energy-intensive products. *Journal of Cleaner Production*, vol. 140 (2017), 1353–1364.

183 Tecchio et al., Understanding lifetimes and failure modes of defective washing machines and dishwashers. *Journal of Cleaner Production*, vol. 215 (2019), 1112–1122.

(i.e. abiotic depletion of elements) occur mainly in the production phase.[184] Improvements in efficiency (for instance, sensor technology) also mean there is a slight shift of environmental impacts from the use stage towards the production phase is occurring over time.

A WRAP study[185] investigated replacing washing machines versus extending lifetime through repair/refurbishment. The study found refurbishment was environmental beneficial (with the exception of water use) in half of the scenarios examined. The benefits of upgrading depended on the energy rating of the upgrade, and the report found benefits if replacing new with the most energy-efficient product on the market, but not if replacing with lower rated energy-efficient models. The report also found a need to look at more particular use scenarios as these are based on scenarios in literature rather than actual user data, which is often the case (i.e. use of stylized user patterns are often used in absence of real user data though this may change with increasing market penetration of connected devices that can report user patterns). Real user data can also address issues with assumptions about use patterns for energy-efficient products (i.e. it is often assumed they will be used in "eco-modes", and real-life usage deviates significantly from these assumptions.[186] Lastly, the report suggested that trade-offs (e.g. water use versus other environmental impacts) should also be considered within the local context.

A study by Devoldere et al., which suggested longer lifetimes and reuse is more appropriate for higher end and more efficient machines and not recommended for lower quality and less efficient models.[187] This is confirmed by O'Connell, et al. in their study[188] of longer lifetimes and reuse of washing machines in Ireland and a similar study in Germany.[189] Both studies recommended re-use of all 'A' and 'B' rated washing machines would be the more sustainable strategy. The O'Connell study also found that in the context of low intensity of use (i.e. used in a summer house), use of refurbished 'C' rated refurbished washing machines could also be recommended for environmental benefits, particularly in the context of decarbonizing electricity due to energy policies in Ireland.

Ardente and Mathieux[190] analyse whether it is environmentally beneficial to extend the average lifetime of a washing machine (assumed to be 11.4 years) through repair by 1 to 4 years. In order to better understand trade-offs between impacts, they focused on modelling global warming potential (generally dominated by energy-use, in the use stage for washing machines), abiotic depletion potential (generally dominated by manufacturing) and terrestrial ecotoxicity (generally influenced by both stages) They found that the extension of the lifetime of the washing machine considered by 4 years reduced the life-cycle global warming impacts by 3 %, compared to the replacement of the old product with a 10 % more efficient one. The results were larger for abiotic depletion (up to 25 % less, independent of the assumptions about the replacement product

184 Stamminger et al., 2018.

185 WRAP, *Environmental life cycle assessment (LCA) study of replacement and refurbishment options for domestic washing machines*, 2010.

186 Sivitos et al., Don't just press the button! – Why appliance settings increasingly matter for efficiency delivery and rulemaking, in *ECEEE Summer Study Proceedings*, 2015.

187 Devoldere et al., The eco-efficiency of reuse centres critically explored-the washing machine case. *International Journal of Sustainable Manufacturing*, vol. 1 (2009), 265–285.

188 O'Connell et al., Evaluating the sustainability potential of a white goods refurbishment program. *Sustainability Science*, vol. 8 (2013), 529–541.

189 Boldoczki et al., 2020.

190 Ardente and Mathieux, 2014.

efficiency), indicating that impacts that generally relate to manufacturing stages always decrease with lifetime extension.

However, like LCA studies of other product groups, Ardente and Mathieux concluded that the benefits of longer lifetimes for products like washing machines are variable for different impact categories, the impacts of extension strategy (e.g. repair), and the efficiency of the replacement product. Schmitz et al. also note the trend of consumers buying larger capacity washing machines while still washing the same amount of laundry, which can also influence assumptions about the actual efficiency benefits of replacement.[191] Bakker and Schuit[192] recommend that a washing machine should be used at least 10 years before replacement and that the new model should have a significantly higher energy efficiency than the old model (at least 15–20 % more efficient – referring to the Ardente and Mathieux study, again the exact "break-even" point depends also on additional factors such as how much time the original has been in use, assumptions about use scenarios, etc.).

Vacuum cleaners

Durability criteria in the European Ecodesign Directive requires the motor to have a minimum operational lifetime of 500 hours, and the hose to have a minimum durability of 40,000 oscillations.[193] This translates to a lifetime of at least 5 years (assuming 2 hours of vacuum cleaning per week (with light to intense use scenarios varying between 15 minutes/week to 4 hours/week)[194].

A study by Bobba et al.[195] found that extending the lifetime of a vacuum cleaner has some environmental benefits even with development of more energy efficient products. For example, in the extension of the lifetime of a vacuum by 100 hours (roughly 2 years) saved around 1.7 % of the global warming impact compared to the replacement of a 15 % more efficient vacuum. Replacement rather than lifetime extension only made sense for global warming impacts when the replacement was at least 25 % more energy efficient, and this scenario still resulted in increased non-climate impacts like abiotic depletion and human toxicity. Lastly, the study revealed benefits to less intense repairs (compared to high intense repairs) in prolonging life were preferable for increased environmental benefits, highlighting additional benefits to simpler repair and maintenance for lifetime extension.

In their study of vacuum cleaners and nine other small household electrical appliances, Bovea et al.[196], assumed a 7-year lifetime for vacuums and compared this to extended lifetime through repair and early replacement scenarios. The study found that the year of replacement of small household appliances generally affected the environmental impact more than repair did.

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191 Schmitz et al., Large Washing Machines Are Not Used Efficiently in Europe. *Tenside Surfactants Detergents*, vol. 53 (2016), 227–234.

192 Bakker and Schuit, 2017.

193 Maitre-Ekern and Dalhammar, 2016.

194 Bobba et al., *Technical support for Environmental Footprinting, material efficiency in product policy and the European Platform on LCA – Durability assessment of vacuum cleaners*, 2015.

195 Bobba et al., Environmental and economic assessment of durability of energy-using products: Method and application to a case-study vacuum cleaner. *Journal of Cleaner Production*, vol. 137 (2016), 762–776.

196 Bovea et al., Variables that affect the environmental performance of small electrical and electronic equipment. Methodology and case study. *Journal of Cleaner Production*, vol. 203 (2018), 1067–1084.

Lighting products

Previous LCA research for lighting products has found that longer lifetimes decrease overall environmental impacts from LED lighting products.[197] However, these LCAs did not consider the improving efficacy of LED lighting products and compare LEDs to LEDs and product developments.

Richter et al.[198] use an LCA approach to model the impacts of longer and shorter lifetimes for LEDs. The findings are similar to other products with most impacts in the use stage in an EU context (e.g. washing machines, ovens, refrigerators, etc.), i.e. that longer lifetimes are better for some impacts related to product (e.g. terrestrial ecotoxicity, human toxicity and metal depletion) while worse for other impacts considering the improving energy-efficiency of replacement products. However, the study also investigated other contextual factors that can influence trade-offs, including the electricity context used. The study found that in the context of Norwegian electricity, longer lifetimes were preferred for all but water, ionizing radiation, and land use impacts. This was similar to Swedish context, but with trade-offs in two additional impact categories (ozone depletion and terrestrial ecotoxicity).

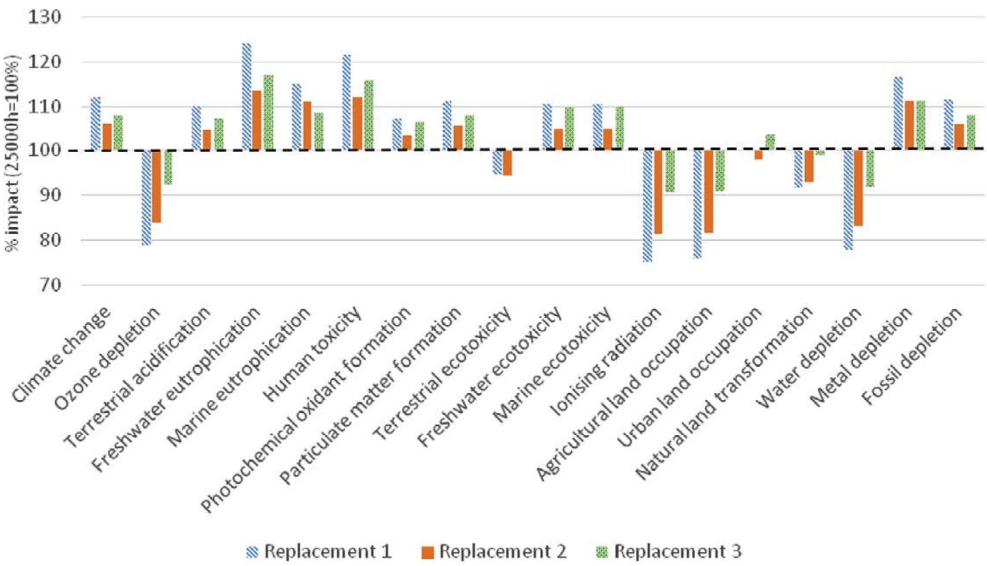

Figure 4. Comparison of environmental impacts of 3 replacement options (original lamp replaced after 5000 h of use) relative to no replacement (i.e. base case the dotted line) in the context of Swedish average electricity mix. The scenarios considered 800 lumen lamps with the original 12.5 w LED from 2012 and possible replacements in 2017: an 8.5w with a 10000h lifetime (replacement 1), a 9.5w lamp with a 25000h lifetime (replacement 2) and an 11w lamp with a 25000h lifetime. While each lamp was similar in function (e.g. white light for household, non-dimming), each had a slightly different material composition that was also captured in the LCA.

[197] Casamayor et al., Extending the lifespan of LED-lighting products. *Architectural Engineering and Design Management*, vol. 11 (2015), 105–122; Tähkämö, *Life cycle assessment of light sources–Case studies and review of the analyses*, 2013.

[198] Richter et al., 2019a

Finally, the study also explored the use of normalization (i.e. weighted environmental impacts, i.e. giving more weigh to some than others based on a panel of experts) which suggested that in the Swedish context, longer lifetimes were preferable for all impact categories except ionizing radiation.

Laptops

Bakker et al.[199] assume an average lifetime of a laptop of 4 years based on their LCA find this should be at least 7 years (and preferably more). An LCA study by Prakash et al.[200] shows that extending the lifetime of modern laptops is the recommended strategy from an environmental perspective because the production phase accounts for the majority (56 %) of the global warming impacts – significantly more than the use phase. Even assuming an energy efficiency improvement of 20 % between laptop generations, the amortization periods are between 17 and 44 years, depending upon the data assumptions for production.

Reuse strategies for laptops have been found to have significant environmental benefits.[201] André et al., 2019 find that this is true even if the reuse period is short. They also find that reuse is important, particularly for critical raw materials that are currently not recycled back into products. Moreover, the study finds that reuse activities can also lead to increased collection and recycling at end of life.[202] LCA studies highlight the production of printed circuit boards, and in particular integrated circuits, as a hotspot for environmental burdens,[203] so repair and refurbishing strategies that keep this component intact can also be assumed to be beneficial.

Smartphones

Smartphones are typically used for 2 years (roughly equivalent to the lifetime of the battery) and are replaced due to deteriorating performance, lack of software support and inability to repair or change the battery, but are often still technically functional or repairable.[204] LCAs for smartphones typically assume 3 years for the lifetime.[205] The production stage accounts for 70 % (± 12 %) of the greenhouse gas emissions in the lifecycle the majority of other environmental impacts are also highest in the production stage, so using smartphone longer would decrease environmental impacts.[206]

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199 Bakker et al., 2014.

200 Prakash et al., *Timely replacement of a notebook under consideration of environmental aspects*, 2012.

201 Boldoczki et al., 2020.

202 André et al., Resource and environmental impacts of using second-hand laptop computers: A case study of commercial reuse. *Waste Management*, vol. 88 (2019), 268–279.

203 Liu et al., State of the art in life cycle assessment of laptops and remaining challenges on the component level: The case of integrated circuits, in *Towards Life Cycle Sustainability Management,* p. 501–512, 2011.

204 Marcus et al., *Promoting product longevity*, 2020; Proske and Jaeger-Erben, Decreasing obsolescence with modular smartphones? – An interdisciplinary perspective on lifecycles. *Journal of Cleaner Production*, vol. 223 (2019), 57–66; Wieser and Tröger, Exploring the inner loops of the circular economy: Replacement, repair, and reuse of mobile phones in Austria. *Journal of Cleaner Production*, vol. 172 (2018), 3042–3055.

205 Proske et al., *Life cycle assessment of the Fairphone 2*, 2016

206 Clément et al., Sources of variation in life cycle assessments of smartphones and tablet computers. *Environmental Impact Assessment Review*, vol. 84 (2020), 106416.

Modularity has been discussed as an optimal lifetime extension strategy for smartphones as well as lighting[207]. Modularity requires additional material for the modules, additional connectors, and possible pre-production of spare parts and the need for easy-to-open designs can increase the risk of water and dust.[208] An LCA of the modular designed Fairphone2 analysed the additional impact of the modularity, as well as the environmental effect of possible repairs. When modularity and repairability leads to a lifetime or 5 years, instead of 3 years, the global warming impact per year of use decreases by 28 % and compensate for the higher initial impact associated with modularity.[209] Repairs can also lead to less loss of many critical materials that are not currently functionally recycled.[210] The focus of modularity for optimal environmental benefit is to focus on keeping parts with the highest environmental impact, like the mainboard/computing/storage module, in use for as long as possible and ensure components requiring upgrading or replacement can be removed and replaced easily (e.g. batteries, cameras, etc.).[211]

Televisions

TVs is another case of products that, despite using energy, have the highest environmental impacts in the extraction of materials and production stages of the lifecycle.[212] Using these products longer would result in less environmental impacts. This is particularly true for TVs where product developments (e.g. larger screens, increased features, growing network infrastructure needs) have led to overall increases in total energy consumption with newer replacement products. A consumer is likely to replace a TV with a larger, smarter TV with decreased environmental benefits. It is also important to note that these products can also be replaced before their technical functional lifetime due to consumer preferences for newer product features and incompatibility with upgraded systems.

Electric vehicles

A review study found the average lifetime for new hybrid and electric vehicles vary widely, most often assumed to be around 12 years and between 100,000 and 240,000 kilometres.[213] The review also showed the increase in the relative importance of the manufacturing stages with increasing electrification and decreasing fossil fuels in electricity production. It also showed the high energy and resource demand in the manufacturing of batteries –

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207 E.g. https://www.zhagastandard.org/

208 Schischke et al., Modular products: Smartphone design from a circular economy perspective, in *Conference Proceedings Electronics Goes Green 2016+ (EGG)*, 2016.

209 Proske et al., 2016.

210 Ljunggren Söderman and André, Effects of circular measures on scarce metals in complex products – Case studies of electrical and electronic equipment. *Resources, Conservation and Recycling*, vol. 151 (2019), 104464.

211 Bovea et al., Repair vs. replacement: Selection of the best end-of-life scenario for small household electric and electronic equipment based on life cycle assessment. *Journal of Environmental Management*, vol. 254 (2020), 109679; Proske and Jaeger-Erben, 2019.

212 Huulgaard et al., Ecodesign requirements for televisions-is energy consumption in the use phase the only relevant requirement? *The International Journal of Life Cycle Assessment*, vol. 18 (2013), 1098–1105.

213 Nordelöf et al., Environmental impacts of hybrid, plug-in hybrid, and battery electric vehicles – What can we learn from life cycle assessment? *The International Journal of Life Cycle Assessment*, vol. 19 (2014), 1866–1890.

also underscoring the importance of considering longer lifetimes also for components. Some studies have already reviewed LCAs showing environmental benefits to pre-use, reuse, and repurposing of batteries from electric vehicles.[214]

As with other improving products, extending the lifetime of existing vehicles risks a delay in the take-up of new electric vehicles and self-driving vehicles.[215] Uncertainties about product developments and user mobility patterns also present challenges that render LCA studies quickly obsolete.[216]

Clothing

There is a wide range of assumptions made about the lifetime of clothing. A WRAP study assumes the average lifetime of a garment is just over 3 years, with a t-shirt having the shortest lifetime (2.7 years) and a coat the longest (4.6 years), based on surveys of consumers in the UK.[217] These projections are based on a survey of consumers in the UK and do not reflect technical lifetimes, but rather the perceived functional and fashionable lifetimes. A pick analysis of textile waste in Sweden found 59 % of annual textile residual waste was in a reusable condition.[218], demonstrating it is common that textiles are consumed faster than their technical lifespans.[219]

LCA studies show that the production stage of clothing is by far the most significant lifecycle stage, with an estimated 75 % of greenhouse gas emissions and 90 % of the water use. The use stage represents the stage with the second largest impacts, though these range significantly based on assumptions about washing and drying practices.[220] Extending the lifetime of clothing leads to decreased environmental impacts as long as this is assumed to be displacing purchasing new clothing.[221]

Other products

A study of assessing cases of durability or refurbishment for multiple "passive" products including a tent, flag, recycling bin, and waste inlet door found that durability resulting in decreased environmental impacts for all products and scenarios.[222] Furniture also has its most significant environmental impacts in the production and manufacturing stages[223], implying longer lifetimes for these products also leads to environmental gains. However, modularity will also be important as furniture is designed with smart features[224]

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214 Albertsen, 2020.

215 Marcus et al, 2020.

216 Ambrose et al., Trends in life cycle greenhouse gas emissions of future light duty electric vehicles. *Transportation Research Part D: Transport and Environment*, vol. 81 (2020), 102287.

217 WRAP, *Valuing our clothes: The cost of UK fashion*, 2017.

218 Muthu, Environmental impacts of the use phase of the clothing life cycle, in *Handbook of Life Cycle Assessment (LCA) of Textiles and Clothing,* p. 93–102, 2015.

219 Roos et al., Will clothing be sustainable? Clarifying sustainable fashion, in *Textiles and clothing sustainability*, p. 1–45, 2017.

220 Muthu, 2015; WRAP, 2017.

221 WRAP, 2017.

222 Kaddoura et al., Is Prolonging the Lifetime of Passive Durable Products a Low-Hanging Fruit of a Circular Economy? A Multiple Case Study. *Sustainability*, vol. 11 (2019), 4819.

223 Wenker et al., A Methodical Approach for Systematic Life Cycle Assessment of Wood-Based Furniture. *Journal of Industrial Ecology*, vol. 22 (2018), 671–685

224 Dragomir et al., *Dealing with component lifecycle disparity in smart furniture*, 2015.

6.1.3 Summary

Table 17. Summary of product lifetime studies

All products	In a decarbonized electricity mix, generally longer product lifetimes are preferred. As energy-efficiency improvements of newer products slow, preference for longer lifetimes increases.
Refrigerators	Increased energy efficiency of current products and slowing rate of improvement indicates there is a "break-even" point. Use patterns and contextual factors will change the optimal product lifetime.
Ovens	Energy efficiency improvements of 15 % were found sufficient to warrant replacement after 10 years versus extended lifetime to 15 years.
Washing machines	Energy efficiency improvements of 15–20 % were shown to favour replacement over lifetime extension. However, user practices (e.g. replacement with higher capacity that is under-utilized) have not been taken into account in LCAs. Lower intensity use scenarios also favoured lifetime extension.
Vacuum cleaners	Extension of lifetime preferred unless energy-efficiency improvements are more than 25 %.
Lighting Products	Increased energy efficiency of current products and slowing rate of improvement indicates there is a "break-even" point. Use patterns and contextual factors will change the optimal product lifetime. Modular systems can be key to extending lifetimes while allowing upgrading of components that are more efficient.
Laptops	Highest environmental impacts in production means longer lifetimes preferred. Functional obsolescence means upgrading needed to extend product lifetimes.
Smartphones	Highest environmental impacts in production means longer lifetimes preferred. Functional obsolescence means upgrading needed to extend product lifetimes.
Electric vehicles	Highest environmental impacts in production means longer lifetimes preferred. Extending component lifetimes and modularity is also important.
Clothing	Highest environmental impacts in production means longer lifetimes preferred. Fashion obsolescence means upgrading needed to extend product lifetimes.
Other passive products	Highest environmental impacts in production means longer lifetimes preferred. Functional obsolescence means upgrading/modularity is likely needed to extend product lifetimes.

The LCA studies indicate that promoting longer lifetimes of product groups with highest environmental impacts in the production stage is preferred. For products with the highest environmental impacts in the use stage, rapid technological changes and varying consumer behaviour need to be considered and there are likely trade-offs between energy and material/toxicity-related environmental impacts in a context using an electricity mix with fossil fuels. It is important to consider a broad range of impacts (i.e. not just climate impacts) in order to fully assess these trade-offs. Also, issues like critical raw materials that are not currently functionally recycled are currently not well-accounted for in most LCAs but should also be considered in assessments of lifetimes.

Several studies also confirmed the importance of electricity mix for environmental impacts in the use stage, which then has implications for whether this stage should be prolonged.[225] A less carbon-intensive and more renewable electricity mix minimizes the

[225] Baxter, 2019; O'Connell et al., 2013; Richter et al., 2019a.

trade-offs between environmental impacts in the case of improving product efficiencies. It is then important that developments leading towards increased renewable energy in the electricity mix are considered in determining the overall impact of longer product lifetimes as it was shown to both minimize the overall impacts of the LED lamps and minimize the trade-offs.

LCA studies examining the effect of increasing the minimum *technical*[226] lifetimes mainly focus on “workhorse” appliances, i.e. products like ovens, refrigerators and washing equipment, and small household electrical products (e.g. vacuums, toasters, etc.) that are less subject to other obsolescence factors (e.g. fashion) for determining their optimal lifetime.[227] As products with the significant environmental impacts in the use stage, these products generally have trade-offs that need to be considered. The optimal lifetimes[228] for these products depend on the following factors:

- The energy context in which they are produced and used: trade-offs and overall use impacts are decreasing when the share of renewable energy in the energy mix is increasing.
- The intensity of use: longer lifetimes or continued reuse may be desirable even with better efficiencies of replacements, if the reused product is used less intensely.
- The efficiency of base product: the more efficient the product to begin with, the more likely longer lifetimes lead to less environmental impact.
- The rate of product development for products with highest impacts in use stage: the more likely that the replacement product represents significantly better energy efficiency (e.g. 15–20 % in some studies reviewed), the more likely that replacement is preferred over longer lifetimes and reuse.
- Efficiency of the replacement: product development implies more efficient products are available on the market. However, consumers looking at the choice of reuse versus replace may be especially motivated by cheaper prices. If reused products are compared to the cheapest available ones, the results of the comparison shift in favour of reuse.[229]

As product development matures and electricity is decarbonized, all products should increasingly be used as long as possible and increases in lifetime will result in decreased in most environmental impacts. Maintenance and repair might be needed to enable lifetime extension, and simpler maintenance and repair not only reduce environmental impacts, but also make it more likely that the user will do these tasks.[230]

For products with most environmental impacts in production like computers, TVs, phones, furniture and clothing, increasing product lifetimes also results in significantly less environmental impacts, regardless of electricity context and even with consideration of any energy and material inputs of repairs and modular designs. Modularity and upgradability are key enablers to extending the *functional* lifetime of these products,

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226 See definitions in chapter 2, and discussion in chapter 4.

227 Iraldo et al., 2017.

228 Here, ’optimal’ lifetimes implies the lifetime with ’lowest environmental impact’. See also chapter 2.

229 Boldoczki et al., 2020

230 van Nes and Cramer, Influencing product lifetime through product design. *Business Strategy and the Environment*, vol. 14 (2005), 286–299.

as consumer needs and demands change. Ecodesign strategies enabling longer lifetimes like modularity or repair should also take into account the components with the most significant environmental impacts in order to optimize these strategies for greater environmental benefits.

LCAs consider environmental impacts and can highlight trade-offs between them. Trade-offs between types of environmental impacts are well-documented in the LCA literature. However, possible trade-offs associated with time-shifting (i.e. delaying) recycling though longer lifetimes and reuse have not been sufficiently considered by LCA research. Also, actual use and replacement patterns are often not the basis of LCA scenarios and this needs to be considered alongside LCA studies.

It is also important to consider that there can be trade-offs between environmental and social or economic impacts as well. For example, often lifetimes are prolonged though donation or sale of products to less wealthy countries. While there can be social and economic benefits to the extended use of products in developing countries, these can be a trade-off with increased environmental impacts compared to newer products and use scenarios in industrialized countries. The economic and social benefits might mean that the best strategy in these cases it to mitigate environmental impacts through information to optimize efficiency, repairs, and upgrades.[231] LCA results should be considered with life cycle costing and social life cycle assessments for a better understanding of the full sustainability impacts of longer lifetimes.

[231] Van Buskirk et al, Refrigerator efficiency in Ghana: Tailoring an appliance market transformation program design for Africa. *Energy Policy*, vol. 35 (2007), 2401–2411.

7 Consumer attitudes towards product lifetimes and product repairability

This chapter gives an overview of consumer knowledge and perceptions of product lifetimes and expands on issues regarding the availability and influence of information and labelling of product durability.

7.1 Product labelling and consumer choice

There is a variety of approaches to steer consumer preferences within the marketplace. Product labels can inform the consumers and indicate certain desired or undesired properties that a product possesses. An important goal of consumer policy is to empower consumers to make informed choices by means of providing sound and adequate information.[232] Environmental labelling and similar information tools are regarded as promising means to assist consumer decision-making,[233] but studies have shown that consumers can become easily confused by the amount and diversity of information.[234]

There are several ways that information can be provided at the point of sale (physical or virtual) including product labels (e.g. ecolabel, quality label etc.), the input of knowledgeable staff, product shelf description, smartphone applications (e.g. using a QR code). However, the provision of ecolabels is widely regarded by consumers as the most direct way to obtain information on the environmental impact of products at the store. Consumers rely on labels to make up for their lack of knowledge and understanding of the environmental impact of what and how they consume.[235] Over the last two decades a large number of ecolabels and certification schemes have been implemented worldwide.[236] The mandatory EU Energy Label, for instance, has indeed proven to be an effective tool in driving consumer choice,[237] especially when combined with binding requirements on product energy efficiency performance (ecodesign requirements).[238] However, research indicates that while consumers can understand the scale of the energy label (built on an A–F scale with colours supporting the letters, e.g., dark green for A-labelled products), they usually cannot understand more complex information provided on the label such as estimated yearly energy consumption[239] or the environmental footprint.

232 Thøgersen, How may consumer policy empower consumers for sustainable lifestyles? *Journal of Consumer Policy*, vol. 28 (2005a), 143–178.

233 Thøgersen, Promoting green consumer behavior with eco-labels, in *New tools for environmental protection: Education, information, and voluntary measures*, p. 83–104, 2002.

234 Leire and Thidell, Product-related environmental information to guide consumer purchases – A review and analysis of research on perceptions, understanding and use among Nordic consumers. *Journal of Cleaner Production*, vol. 13 (2005), 1061–1070.

235 SIRCOME et al., *The influence of lifespan labelling on consumers*, 2016.

236 Gruere, An analysis of the growth in environmental labelling and information schemes. *Journal of Consumer Policy*, vol. 38 (2015), 1–18.

237 VHK, *Ecodesign impacts accounting – Annual Report 2016*, 2016.

238 Dalhammar et al., 2018.

239 Waechter et al., Desired and undesired effects of energy labels – An eyetracking study. *PLoS One*, vol. 10 (2015), 1–26.

Literature findings indicate that the effectiveness of ecolabels depends both on how the information is presented and on the capacity of consumers to effectively understand that information and act on it. For example, quantitative and comprehensible information are assumed as more reliable by consumers.[240] In theory, there are certain preconditions that need to be fulfilled for a labelling scheme to have the intended effect, including the following:

Trust. A basic precondition for the success of a label is that consumers trust the label. Usually, a commercially independent third party and multi-stakeholder involvement are critical for building up trust and boosting the uptake of a labelling scheme.[241] Transparency and availability of underlying data is also important for maintaining the trust of consumers. Self-funded voluntary ecolabel schemes can suffer from poor and slow processes that result in decline of reputation and uptake. On the other hand, a mandatory label scheme could be a preferable option, since these generally enjoy broader recognition and support among consumers, and provide a level playing field for producers.[242] Government involvement in ecolabels generally improves uptake, and governments can use ecolabelling in conjunction with other mechanisms such as procurement policies to support the ecolabel schemes.[243]

Understanding. Another equally important precondition is that consumers can recognize and understand the label.[244] Uncertainty about the meaning of a label, or about the issuing authority, may severely impair consumers' trust in the label. Generally, consumers are attracted to simple ecolabels that convey directly the required message,[245] but sometimes simplicity can undermine the efficacy of environmental claims.[246] Also, the label must be easily understood so that consumers can be able to compare and choose between products based on the information of the label.[247]

Design. Ecolabels come in a variety of styles that use both imagery and text to convey a message. Both textual and graphical elements of ecolabels can influence the consumer's choice independently, but the combination of both in the label elicits greater effectiveness and willingness to pay.[248] Adding quantitative information to a label appears to have no impact on a label's credibility.[249] In a recent study[250], the participants identified and

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240 SIRCOME et al., 2016.

241 Horne, Limits to labels: The role of eco-labels in the assessment of product sustainability and routes to sustainable consumption. *International Journal of Consumer Studies*, vol. 33 (2009), 175–182; SIRCOME et al., 2016.

242 Horne, 2009.

243 Gåvertsson, et al., Quality Labelling for Re-used ICT Equipment to Support Consumer Choice in the Circular Economy. *Journal of Consumer Policy*, vol. 43 (2020), 353–377.

244 Van Dam and Reuvekamp, Consumer knowledge and understanding of environmental seals in the Netherlands, in *European advances in consumer research* (Vol. 2), p. 217–223, 1995.

245 SIRCOME et al., 2016.

246 Horne, 2009.

247 UNEP, *Guidelines for Providing Product Sustainability Information. Global guidance on making effective environmental, social and economic claims, to empower and enable consumer choice*, 2017.

248 Tang, et al., Visual and Verbal Communication in the Design of Eco-Label for Green Consumer Products. *Journal of International Consumer Marketing*, vol. 16 (2004), 85–105.

249 Teisl et al., Non-Dirty Dancing? Inter-actions between Eco-Labels and Consumers. *Journal of Economic Psychology*, vol. 29 (2008), 140–159.

250 Ní Choisdealbha and Lunn, Green and Simple: Disclosures on Eco-labels Interact with Situational Constraints in Consumer Choice. *Journal of Consumer Policy*, vol. 43 (2020), 699–722.

chose more environmentally friendly products when information was formatted on a standardized color-coded scale rather than presented as specific verbal information. Consumers were unaffected by whether disclosures were framed positively or negatively.

However, no matter how a labelling scheme is designed, sociological and environmental studies demonstrate that provision of information does not necessarily lead to changes in attitudes, and even when it does, the change does not always translate into behaviour change.[251] A great deal of everyday consumption takes place around habitual social practices which are not cantered on apparent consumption, but around practice norms.[252] Consequently, changes in purchasing norms and habits of consumption may not come directly as a result of an ecolabel.[253]

To overcome this behavioural barrier there are different ways in which information provision can lead to a deeper behavioural change. Information must be able to create attention and capture the interest of the consumer. In a media-congested modern society, to highlight an issue and to be able to discern its importance among other diverse signals is paramount.[254] Once the issue is highlighted, the information provided must be able to create positive attitudes towards a behavioural solution. This means that consumers not only need to know about a certain issue, but also to be given appropriate information on how to deal with this issue.[255]

Responsiveness to product labelling systems also appears to depend on the demographic characteristics of consumers.[256] Consumer income level, for example, is consistently associated with higher willingness to pay for an ecolabelled product.[257] Female consumers are typically more willing to pay higher premiums for ecolabelled products than males.[258] Age is also highlighted as an important parameter in some studies, although the results are mixed.[259] The level of education is seen as an indicator of higher uptake of ecolabels, as well as the general knowledge of consumers regarding related environmental issues and prior environmentally responsible behaviour.[260]

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[251] Mont and Power, The role of formal and informal forces in shaping consumption and implications for sustainable society: Part I. *Sustainability*, vol. 2 (2010), 2232–2252.

[252] McKenzie-Mohr and Smith, *Fostering sustainable behaviour – An introduction to community based social marketing*, 1999.

[253] Horne, 2009.

[254] Thøgersen, Consumer behaviour and the environment: Which role for information? In *Environment, information and consumer behaviour*, p. 51–63, 2005b.

[255] SIRCOME et al., 2016.

[256] Boyer et al., Product Labels for the Circular Economy: Are Customers Willing to Pay for Circular? *Sustainable Production and Consumption*, vol. 27 (2021), 61–71.

[257] Sønderskov and Daugbjerg, The State and Consumer Confidence in Eco-Labeling: Organic Labeling in Denmark, Sweden, The United Kingdom and The United States. *Agriculture and Human Values*, vol. 28 (2011), 507–517.

[258] Harms and Linton, Willingness to Pay for Eco-Certified Refurbished Products: The Effects of Environmental Attitudes and Knowledge. *Journal of Industrial Ecology*, vol. 20 (2016), 893–904.

[259] Ward et al., Factors Influencing Willingness-to-Pay for the ENERGY STAR® Label. *Energy Policy*, vol. 39 (2011), 1450–1458.

[260] SIRCOME et al., 2016.

7.2 Consumer understanding of product lifetimes and perception of durability

Expectations of product lifetimes differ widely among consumers and the answer to the questions of "What is a durable product?" and "How long a product is expected to last?" is not as obvious as it may seem. In this section, we will explore the understanding of consumers regarding product lifetimes and what do they perceive as product "durability". Finally, we will identify the reasons behind perceived obsolescence and why consumers are more than willing to part with their prized possessions long before they reach their end of life.

7.2.1 Understanding of product lifetimes

The results of an immersive consumer study[261], with dedicated focus groups on understanding product lifetimes, demonstrate that consumers expect constant and rapid up-dating of products. In particular, having the latest versions of products is strongly associated with personal identity and feelings of success in life. There is little evidence of concern about the environmental consequences of a 'throwaway society'. To refine the findings, a product typology was developed to describe how products meet consumers' various needs and how lifetime is an outcome of the functional life of a product and its lifetime in use by consumers.

The concept of a product lifetime comprises a mix of how long consumers expect something would last before it breaks, and how long they want it to last before they update it.[262] These two dimensions can be characterized as product 'nature' (functional life) and product 'nurture' (or 'willingness to keep'), which influence consumer attitudes and behaviours and ultimately affects a products' lifetime in use.

There is a difference in the way consumers value durability (a product designed to last a long time) and functional reliability (a product performing reliably without breaking down regardless of how long it is built to last). Functional reliability is deemed crucial for all products (even ones expected to be kept for a short time) but durability is only of value for products that consumers expect to keep for a long period of time, e.g. cooking stoves, wardrobes and boilers.[263] Consumers also report that they rely on proxies such as brand and price to formulate judgements about how long a product will last.[264] The conceptual analysis of product lifetime preferences is shown in Figure 5.

[261] Cox et al., Consumer understanding of product lifetimes. *Resources, Conservation and Recycling*, vol. 79 (2013), 21–29.

[262] Ibid.

[263] Ibid.

[264] Cooper, Inadequate life? Evidence of consumer attitudes to product obsolescence. *Journal of Consumer Policy*, vol. 27 (2004), 421–449.

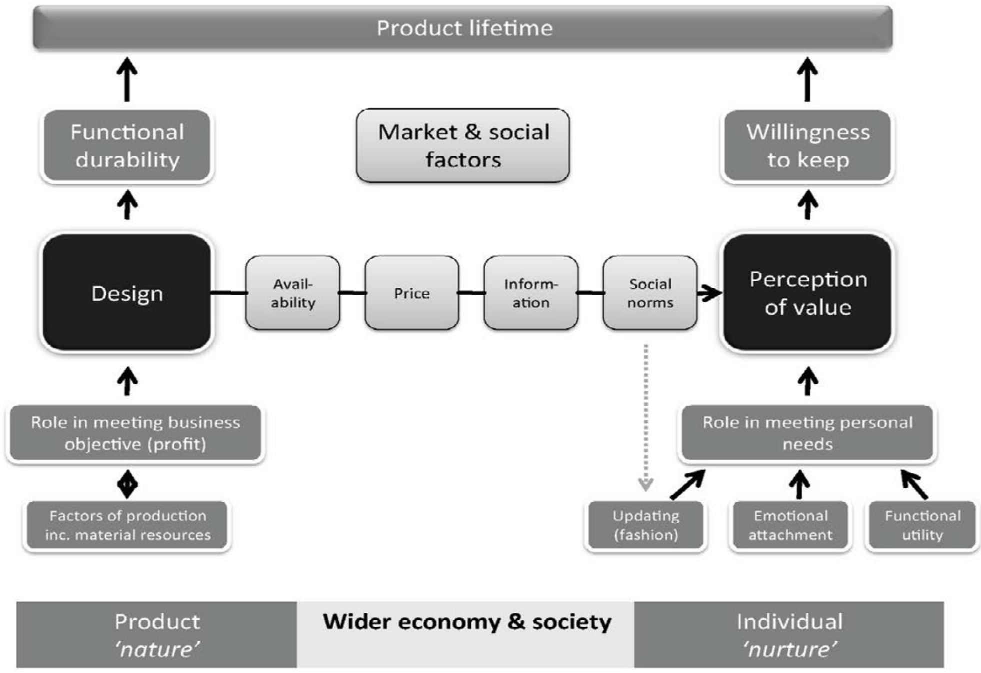

Figure 5. Model of the formulation of consumer product lifetime preferences.[265]

Taking into account the variations in how consumers perceive the lifetime of a product and how do they look after their products makes the idea of durability labelling problematic because the same type of item will last different amounts of time in the hands of different consumers.[266] However, it appears unlikely that consumer attitudes or behaviours towards product lifetimes will change on their own, and therefore a wide range of interventions would be required. The prevalence of cheap products on the market reinforces an updating mind-set in consumers, and renders previously durable products to the status of semi-disposable.[267] To extend product lifetimes, change is required in the consumer environment in which purchasing decisions are made, so that consumers can begin to feel they have the 'right' information and that they are not 'locked in' to a 'throwaway' consumption culture.

7.2.2 Perception of durability

Braithwaite et al.[268] reviewed the relevant literature on consumers' durability perception. They found that the meaning of durability varies among consumers, and that it is usually linked to products that have lifetime guarantees or have parts that can be updated or modified. Durability is also linked to the product's performance over time. Similarly, a study by Defra[269] found that perceptions of durability can be fluid between individuals,

[265] Cox et al., 2013.

[266] Cooper and Christer, Marketing durability, in *Longer lasting products: alternatives to the throwaway society*, p. 273–296, 2010.

[267] Cox et al., 2013.

[268] Braithwaite et al., Should energy labels for washing machines be expanded to include a durability rating? In *PLATE 2015 Conference Proceedings*, 2015.

[269] Defra, *Public understanding of product lifetimes and durability (1)*, 2011.

making it difficult to generalise its meaning. Durability is not a characteristic that consumers consciously consider at the time of purchase and instead they use proxies like e.g. product quality as an indicator of expected lifespan. Moreover, the durability of a product is perceived by how long the product provides a useful service to them.[270]

However, there is also evidence that consumers think products do not last as long as they should.[271] Echegaray[272] reports that 66 % of 806 Brazilian respondents feel that product lifespans fall short of what they deem to be reasonable. Cooper[273] finds that 45 % of 802 British households were of the opinion that their household appliances do not last as long as they would like. Finally, Wieser et al.[274] based on a survey with over 1000 Austrian residents, find that the respondents want products to last longer than they are currently used.

According to interview findings[275], consumers stated that expected years of product use would be a clear indicator of durability. Moreover, interviews confirmed that the manufacturers' standard guarantees are important as a sign of reliability which may link to durability[276]. However, there was little interest in extending guarantees or investing in repair and service options in this study. This may indicate that consumers do not always see value in maintaining and repairing products as they are expected to only last a short amount of time and repair can be expensive.[277]

Consumers in general prefer more durable products[278], but the relatively high price of these products might prevent them from actually buying more durable alternatives. Consumers are willing to repair their product for extended periods of time.[279] However, in practice, this willingness is often countered by factors related to the price of repair and its relation to the original purchase price, the perceived residual value of their product, the uncertainty of the outcome of the repair and how long the product will last before another repair is needed.[280]

7.2.3 Perception of product obsolescence

There is a variety of reasons that affects consumers' decision of discarding a product in use, and they are related to different types of perceived product obsolescence and their willingness to replace the product. The different types of perceived product obsolescence

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[270] Knight et al., *Electrical and electronic product design: product lifetime*, 2013.

[271] Bakker and Schuit, 2017.

[272] Echegaray, Consumers' reactions to product obsolescence in emerging markets: The case of Brazil. *Journal of Cleaner Production*, vol. 134 (2016), 191–203.

[273] Cooper, 2004.

[274] Wieser et al., The Consumers' Desired and Expected Product Lifetimes, in *Conference Product Lifetimes and the Environment 2015 Proceedings*, 2015.

[275] Knight et al., 2013.

[276] Ibid.

[277] McCollough, Factors impacting the demand for repair services of household products: the disappearing repair trades and the throwaway society. *International Journal of Consumer Studies*, vol. 33 (2009), 619–626.

[278] van den Berge and Thysen, *State-of-the-art knowledge on user, market and legal issues related to premature obsolescence*, 2020

[279] Ibid.

[280] Ibid.

can be attributed to quality, technological, aesthetic, psychological, economic, ecological, social, and legal reasons.[281] For an overview, see Table 17. Most often, it is the combination of several types of product obsolescence reasons that lead to the eventual decision to discard a product.[282]

Van Nes and Cramer[283] suggested a typology of four general reasons that lead to the discarding or replacement of products. They defined (1) 'wear and tear' in the case a product is broken/does not function anymore; (2) 'improved utility' when the product does not function sufficiently due to improved demands for safety/economy of use of the product; (3) 'improved expression' when the product does not function sufficiently due to comfort/quality/expression reasons; and (4) 'new desires' when the product is functioning well but is ultimately replaced due to a need for special/additional product characteristics that are offered in new products.

'Wear and tear' is linked to the physical obsolescence of a product (physical and or functional deterioration of the product). 'Improved utility' is related to the more "rational" reasoning behind the decision to replace, for instance economical, ecological, technological, social and legislative reasons of obsolescence. Lastly, both 'improved expression' and 'new desires' are related to the more "emotional" reasoning to replace, such as the aesthetic and psychological obsolescence.

Table 18. Different types of obsolescence linked to replacement reasons.[284]

Replacement reasons	Related to:	Type of obsolescence	References
Wear and tear	Product functionality and performance	Quality	Packard, 1960; Mugge et al., 2005; Guiltinan, 2009
Wear and tear and/or improved utility, improved expression, new desires	(Technological) Innovation or developments	Technological	Packard, 1960; Antonides, 1991; Cooper, 2004
Improved expression, new desires	Product appearance (trends in design, signs of wear and tear)	Aesthetic	Packard, 1960; Antonides, 1991; Cooper, 2004
	Social influences (status, peer pressure) and symbolic value of products	Psychological	Cooper, 2004; Burns 2010; Wilson et al., 2017
Improved utility	Value depreciation of the 'old' compared to the 'new' product	Economic	Antonides, 1991; Cooper, 2004; Khan et al., 2018
	The ecological footprint of the 'old' product compared to the 'new' product	Ecological	Wilson et al., 2017
	Social norms of products and its use	Social	Burns 2010; Wilson et al., 2017
	Legislations around products	Legal	Mugge et al., 2005;

281 Ibid.

282 Cox et al., 2013.

283 van Nes and Cramer, 2005.

284 Adapted from van den Berge and Thysen, 2020.

Responses from consumers' surveys show that 31 % of washing machines[285], 66 % of vacuum cleaners[286], 56 % of TVs[287], and 69 % of smartphones[288] were disposed for other reasons than being broken or beyond repair. For three out of four product categories this is above 50 % of the discarded products.

In reality, early replacement of functioning products is most often caused by multiple reasons (types) of obsolescence.[289] For example, a smartphone can be replaced due to a combination of reasons, such as a weak battery, a broken screen and because a newer version is available, thus justifying the replacement decision in the eyes of the consumer.

7.3 Consumer perception of durability labels

There is a number of studies and behavioural experiments regarding consumer responses to various product durability labels and information. In this section, we present the evidence gathered in all the identified studies and experiments about durability labels. Prior to that, we give a brief account of the different types of existing durability/repairability labels and standards.

7.3.1 Background on existing labels and standards for product durability/repairability

A recent study[290] has gathered the existing information regarding tests, rating systems and standards relevant to product durability and premature obsolescence (Table 19). The majority of the existing rating systems focus on repairability of products, and only recently some methodologies include durability assessments (i.e. LONGTIME® tackles repairability, longevity and robustness) and few of them address upgradability aspects (JRC, iFixit version 1 and EN 45554). Overall, the rating systems identified have a generic, horizontal approach and can be used on a wide range of products.

[285] Hennies and Stamminger, An empirical survey on the obsolescence of appliances in German households. *Resources, Conservation and Recycling*, vol. 112 (2016), 73–82.

[286] Harmer et al., Design, Dirt and Disposal: Influences on the maintenance of vacuum cleaners. *Journal of Cleaner Production*, vol. 228 (2019), 1176–1186.

[287] Hennies and Stamminger, 2016.

[288] Wieser and Tröger, 2018.

[289] van den Berge and Thysen, 2020.

[290] Ramos and Fernández, *State-of-the-art existing testing, rating systems and standards*, 2019.

Table 19. Overview of existing rating systems[291]

Existing rating system	Type	Scope	Applicable to
JRC Scoring system for repairability	Scoring system	Repairability, upgradability	Energy related products
Austrian standard ONR 192102:2014	Standard	Repairability, durability	White and brown goods
Groupe SEB's Product 10Y Repairable label	Label	Repairability	Small household appliances
iFixit 1, scoring system for repairability v1 (published)	Scoring system	Repairability, upgradability	Portable IT products
iFixit 2, scoring system for repairability v2 (beta version)	Scoring system	Repairability	Portable IT products
Labo FNAC's Indice de réparabilité	Scoring system	Repairability	Laptops and smartphones
BENELUX study on Repairability criteria for energy related products	Scoring system	Repairability	Energy related products
EN 45554: General methods for the assessment of the ability to repair, reuse and upgrade energy related products	Standard	Repairability, upgradability, reusability	Energy related products
French repairability index (ADEME)	Scoring system	Repairability	Electrical appliances
Repairably (from a Slovakian NGO)	Label	Repairability	Assembled goods
Ease of Disassembly Metric (eDiM)	Metric	Dissassemblability	Electrical appliances
LONGTIME® label	Label	Durability, repairability	Assembled goods

Most of the identified rating systems deal with repairability. They can be used on a wide range of products at European or international level and they commonly assign a weight to several individual criteria and a final score is shown as a label or scale. A label is the option chosen in the SEB, Reparably and LONGTIME® schemes. Alternatively, a scale is the choice in the Austrian Technical Rules ONR 192 (0–5 score), iFIXIT rating system (0–10 score), FNAC repair index (0–10 score) and BENELUX study (percentage). There is still no final decision on how to display the assessment in the JRC scoring system[292] although the index is already defined, and the ADEME repair index label[293] is under development by behavioural scientists.

291 Ibid.

292 Cordella et al., 2019.

293 Hervier et al., *Benchmark international du secteur de la réparation*, 2018.

7.3.2 Evidence of durability labelling – consumer behaviour studies

Labels that display information about the durability or lifetime of a product can enable consumers to consider taking into count the product's lifetime when making purchasing decisions.[294] Additionally, a product's warranty length is regarded as a 'very important' purchasing factor for the majority of product categories.[295] This indicates that the introduction and effective communication of longer lifetime information by manufacturers and retailers may entice consumers to purchase longer-lasting products.[296] Thus, both lifetime/durability labelling and the provision of longer warranties could encourage greater uptake of longer-lasting products.

However, despite the fact that durability labelling is considered in literature as a major enabling factor, few studies actually exist that analyse the purchasing behaviour of consumers under the presence of product durability information, and specifically the effect of a durability label. A total of seven (public) dedicated studies have been identified in literature that conducted extensive consumer experiments aiming at producing knowledge and relevant information regarding the consumers' purchasing decision and willingness to pay for long-lasting products, and the recognition and uptake of durability labels by the average consumer. Below, we present the results of each study individually and we summarize the findings at the end of the chapter.

Study 1: The influence of lifespan labelling on consumers

The most cited study[297] and the one that has achieved a wider following in the area of product life research, is the study conducted on behalf of the European Economic and Social Committee regarding the influence of lifespan labelling on consumers. The main aim of the study was to analyse whether lifespan labelling on products might influence consumers' purchasing decisions. Several ways of displaying this information were tested and different analyses were performed on nine product categories, four label formats, and ranges of purchase prices.

The results of the study show that lifespan labelling has indeed an influence on purchasing decisions in favour of products with longer lifespans. On average, sales of products with a label showing a longer lifespan than the competing products increased by 13.8 %. The degree of influence, however, varied depending on the type of product. There was a significant influence on consumer purchasing decisions in eight out of nine product categories tested: suitcase (highest influence), printer (high), trousers (high), sport shoes (moderate), coffee maker (moderate), washing machine (low), vacuum cleaner (low), and smartphone (lowest influence). Only the simulated purchases of televisions were not significantly affected by the lifespan labelling.

A major finding of the study was that lifespan labelling always influenced purchasing decisions, regardless of the price of products. Also, it was noted that lifespan labelling had more influence on purchasing decisions relating to high-end products than low-end products. Nonetheless, the difference between these product groups was not large, and

[294] Gnanapragasam et al., Consumer perspectives on product lifetimes: a national study of lifetime satisfaction and purchasing factors. In *Product Lifetimes And The Environment 2017 Conference Proceedings*, 2017.

[295] Ibid.

[296] Cooper and Christer, 2010.

[297] SIRCOME et al., 2016.

the results not conclusive about this type of interaction. Moreover, 90 % of respondents said that they were prepared to pay more (willingness to pay) for a similar product (dishwasher) with a lifespan that was 2 years longer.

Although lifespan labelling had an impact on men as well as on women, women were more likely to base their purchasing decisions on this criterion. Lifespan labelling influenced purchasing decisions in all age groups. However, the most receptive to lifespan considerations was the 25–35 age group. People older than 35 were less influenced by lifespan considerations.

To test the purchasing behaviour of consumers, four label designs were offered to the participants of the study (Figure 5). Each one of the labels had effectively influenced purchasing decisions. However, two labels appeared to be particularly effective.

Labels with a scale from A to G (AG) and labels displaying useful lifetime (UL) achieved better results than the other two labels, the label displaying the cost per year (CD) and for the label displaying the lifespan in years (LSY).

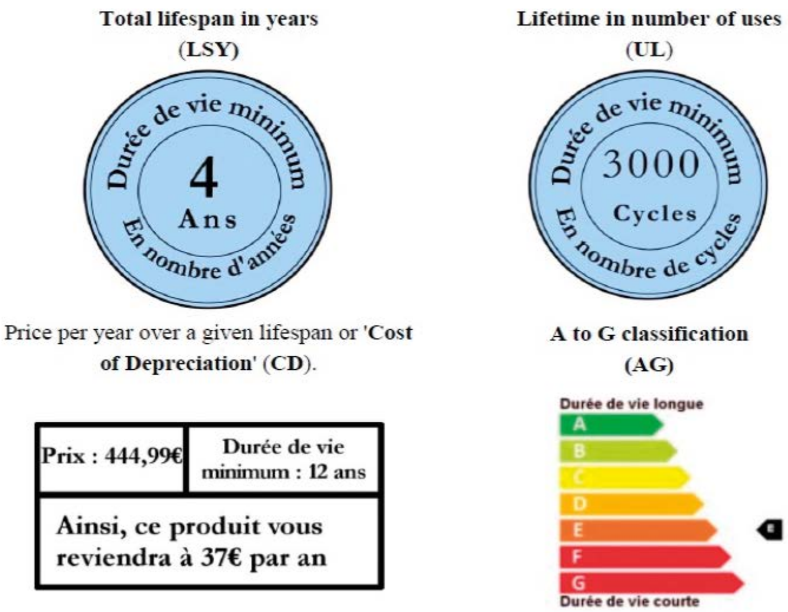

Figure 6. The four designs of lifetime labels tested in the consumer study[298]

The label with the lifespan given as a time period (months, years) was the best understood, with 82 % of participants associating it with the products' expected lifetime. This suggests that useful lifetime (UL) should be displayed in a similar format. In terms of format, however, it was noted that individuals find it difficult to mentally picture – and therefore fully understand – large quantities (e.g. 10 000 hours, 500 wash cycles etc.).

[298] Ibid.

Study 2: Behavioural Study on Consumers' Engagement in the Circular Economy

A more recent study[299] on behalf of the European Commission conducted a behavioural experiment on consumers' engagement in the circular economy, which also included a purchasing experiment that tested different forms of durability and repairability information and their effects on consumers' purchasing decisions. The study tested both the effect of manufacturer warranties and expected lifetime claims, and the durability and repairability ratings included in the EU Energy and Ecolabels using novel icons.

Results showed that consumers mostly associate durability with product quality, while repairability was mostly associated with availability of spare parts. Repairability was throughout the study found to be less important to consumers than durability. According to the consumer survey in the study this is because consumers trust manufacturer warranties and would not expect durable products to break.

Overall, the quality of the product was rated most influential in purchasing decision followed by price. How long the product was expected to last (durability), repairability, the existence of a repair service and environmental credentials were also important to participants. The manufacturer or brand was ranked as less important, and overall participants rated the product being the latest model or trend as even less influential.

When durability information was shown, respondents were significantly more likely to choose more durable products. Participants reported most frequently that they expected durability information via product descriptions as well as via guarantees or warranties. About 30 % of respondents expected to receive information via retailers, operating manuals or instructions, or the manufacturer's website. These were followed by the expectation of receiving information via an EU official label (18–23 %), and an official label from a national authority (14–19 %).

A joint analysis of the behavioural experiment and consumer survey revealed that consumers who have received durability information via manufacturer warranties, or durability promises at the point of sale in a purchasing exercise, were significantly more likely to expect free replacement or free repairs of faulty products. Instead, those who had not seen such information were significantly less likely to expect free repairs or replacements and instead expected to pay for these services.

Study 3: Consumer Market Study to support the Fitness Check of EU consumer and marketing law

Another study[300] on behalf of the European Commission examined a sample of 7 234 consumers from eight European countries that were asked to choose between different washing machines, televisions, and smartphones with different degrees of information about durability and repairability. One of the main outcomes of this study is the positive impact of the presence of durability information on consumers' purchasing decisions. When no information was provided, the items in question were selected by 27 % of the respondents, while 47 % of the respondents chose the same products when such information was present. When durability information was present, respondents were on average willing to pay 5 % more, relative to a baseline price, for products with high durability. Regarding the mode of information provision, the study found that presenting

[299] LE Europe et al., *Behavioural Study on Consumers' Engagement in the Circular Economy*, 2018.

[300] Gfk, *Consumer Market Study to support the Fitness Check of Consumer Rules*, 2017.

durability-related information in terms of years has a slightly more powerful impact than in units (in the study units were presented as specific usage units, e.g. the number of wash cycles for a washing machine).

Study 4: Comprehensibility of the EU Energy Label

A study[301] on behalf of the German regional authorities provided information about the importance of durability in purchasing decisions for electronic equipment. The study presented the outcomes of a survey with 1 050 German consumers. Respondents were asked to rank the importance of a number of factors (including energy efficiency, durability, price etc.) in their last purchase or next planned purchase (Figure 6). Although the most important criteria for consumers when choosing electrical or electronic appliances are the electricity consumption and energy efficiency (49 %), durability is ranked second (43 %), before the price-performance ratio (36 %).

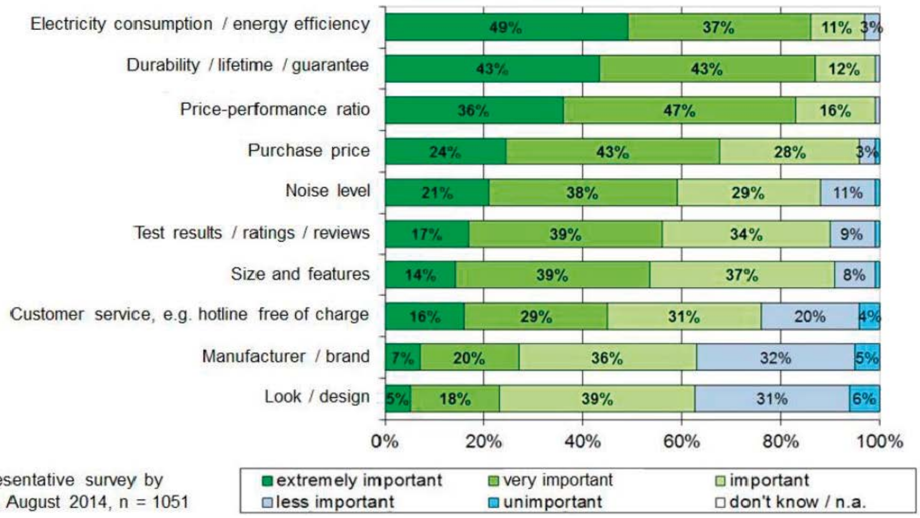

Figure 7. Consumers consideration when purchasing electrical and electronic appliances.[302]

Study 5: Electrical and electronic product design: product lifetime

The previous study highlighted the importance of durability in purchasing decisions of electronic equipment. However, another study[303] found out that consumers' durability considerations when purchasing new electronic appliances might differ depending on the type of electronic appliance. According to a survey with 1104 UK respondents, some participants indicated that they might give greater thought to product lifetimes when buying goods, depending on how likely they thought the product was to break down. For instance, washing machines, vacuum cleaners, and laptops were thought to be more likely to break down than televisions and fridges.

301 Dünnhoff and Palm, *Comprehensibility of the EU Energy Label – Results of two focus groups and a representative consumer survey*, 2014.

302 Ibid.

303 Knight et al., 2013.

Overall, consumers use a combination of general knowledge and proxies (e.g. brands, prices or guarantees) to make assessments about lifetimes of comparable products. Different factors are used by consumers to estimate product durability including design, technological change, the cost of repair, the availability of spare parts, household affluence, aesthetics, functional quality, and fashion.

Study 6: The Influence of Product Lifetime Labelling on Purchasing Electrical Appliances among German Consumers

A pilot study[304] was conducted by researchers in Germany into how consumers would react to a hypothetical product lifetime label. It was framed as a label that was not a guarantee, but simply an indication of expected lifetime, that would be tested by an independent agency.

The methodology of this study included an experimental online survey (choice-based conjoint analysis) on a sample of 409 German consumers, reaching the participants by online panels and personal communications. The analytical framework of the study (Figure 7) was based on a combination of the theory of planned behaviour[305] and the consumer theory of Lancaster[306], to identify the purchasing determinants of consumers.

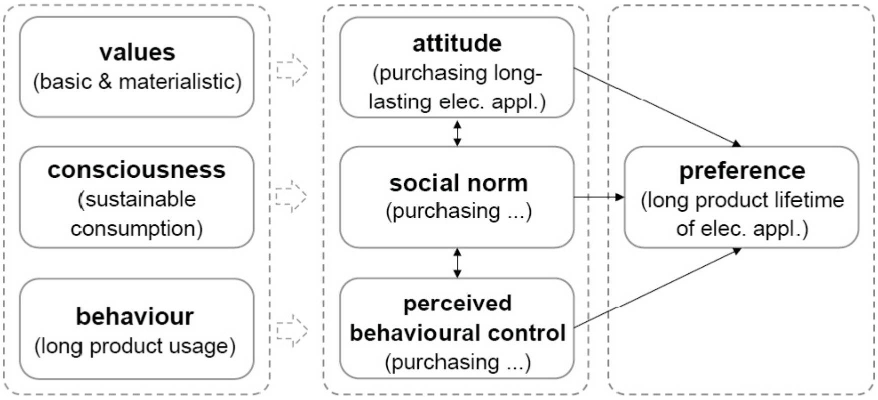

Figure 8. Conceptual model for consumer preference analysis, based on the theory of planned behaviour and the consumer theory of Lancaster.[307]

Although the consumers surveyed said the most important factor – weighted at 33 % – in their purchase decision was price, they ranked the theoretical product lifetime label at 31 %. They gave energy consumption, represented by a label that already exists across the EU, less than half the importance of a product lifetime label.

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304 Jacobs, *The Influence of Product Lifetime Labelling on Purchasing Electrical Appliances among German Consumers*, 2018.

305 Ajzen, The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, vol. 50 (1991), 179–211.

306 Lancaster, A New Approach to Consumer Theory. *Journal of Political Economy*, vol. 74 (1966), 132–157.

307 Jacobs, 2018.

Based on the analytical framework of the study, the results indicated that the preference for durability is driven by both sustainability values of the consumers and 'rational' egoistic motives, such as saving money.

Study 7: Labelling the durability of a product on its packaging: A pilot study

Another pilot study[308] comes from researchers in Belgium who focused on how to frame information about the durability of a product to impact consumers' attitudes and purchase intention. By using a snowball sampling method, the study examined 720 French respondents.

The results showed that durability labelling has a measurable positive effect on consumer attitudes about perceived quality, in particular for low priced products, but no significant impact on willingness to buy. However, the results were incoherent across product categories, types of labelling and profiles of consumers. Moreover, repairability information has a positive impact on consumer attitude and willingness to buy the product, independently of the product price.[309]

7.3.3 Summing up the evidence and implications

The major takeaways from the analysed studies in the previous section include the following:

- The availability of durability information almost certainly influences positively the purchasing decision of consumers, although this might be dependent on the type of product.
- Durability information increases the willingness to pay for a more durable product.
- Durability information is linked to the perception of quality, and it is preferable to repairability information on a product.
- Durability is considered among the top 3 factors influencing the purchasing decision of consumer.
- Demographically, the profile of the consumer who is more likely be influenced by a durability label is a woman in the age 25–35.
- A durability label would be best understood by displaying the useful lifetime of a product (either by unit cycles or life years).

Several implications arise from the results of the studies. It is highlighted that the influence of environmental information may be product dependent. Some studies within the evidence base looked at the same information, but across different types of products. From these studies, it is clear that information or labels that work on one product, may not work on a different product. Understanding what aspects of the information can be more universally applied compared to product specific information will be important. There is evidence that energy labels are less effective on products that are used less regularly, and that the importance of brand to the consumer may affect a label's influence.[310]

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308 Swaen et al., *Labelling the durability of a product on its packaging: A pilot study*, 2014.

309 Swaen et al., *Labelling the durability – the reparability of a product*, 2018.

310 Whittle et al., *The Effectiveness of Providing Pre-Purchase Factual Information in encouraging more Environmentally Sustainable Product Purchase Decisions: Expert Interviews and a Rapid Evidence Assessment*, 2019.

The role of information interacts with price sensitivity and varies across different consumer groups. Across products, price was often reported as being the most influential factor in product choice. Price was also found to interact with the influence of the environmental information. However, there is no evidence as to what the limit would be of the premium people are willing to pay for labelled products. Furthermore, if someone places high importance on price, it is unlikely to be influenced by environmental sustainability information.[311]

Finally, a study[312] prepared for the European Parliament on the subject of promoting product longevity, identified some additional implications in relation to product lifetimes and the information provision to consumers. The most relevant points included the following:

- In terms of environmental objectives, it is not always the case that extending product lifetime is positive. Impacts across the production, usage and end of life phases need to be considered and communicated, as there are often trade-offs among these.
- A one-size-fits-all horizontal approach as regards product lifetime is unlikely to be appropriate – different approaches are suitable to different products at different times. Even for the same product, different approaches may be needed over time in response to market evolution and technological evolution.
- Consumer attitudes towards increased product longevity are distinctly mixed. They would welcome longer product lifetimes for some products, but in other cases worried about high costs of acquiring or maintaining products with long lifetimes, or worried about being locked into obsolescent products.
- Consumers have limited reliable information about product lifetimes and total cost of ownership (i.e. the additional cost of maintaining and upgrading the product for the entirety of its longer lifespan)
- Consumers would benefit, not only from information about service records and expected product lifetime among competing products, but also from comparative statistics on the total cost of ownership.

7.4 Potential application of durability labelling and information display requirements

A study[313] by the French environment and energy agency ADEME presented a comprehensive account on the conditions of introducing a durability label in France and the trade-offs of using other types of labels, e.g. for environmental impacts.

To steer consumer choice towards more environmentally sound decisions regarding purchases of products, there is a variety of informative approaches. Indicating the environmental impact or a product's lifespan aims to guide the consumer's purchasing choice towards the product with the least impact on the environment. For environmental labelling the design of a label can be quite simple, indicating the level of environmental impact in a selected environmental pressure or in an aggregate indicator (e.g. footprint).

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311 Brocklehurst et al., Can the provision of energy and resource efficiency information influence what consumers buy? A review of the evidence, in *ECEEE 2019 Summer Study on Energy Efficiency: Is Efficient Sufficient?*, 2019.

312 Marcus et al., 2020.

313 Fangeat and Chauvin, *Allongement de la durée de vie des produits*, 2016.

The display of the lifespan of a product is a little more complicated. It must be noted that environmental analysis of potential impacts is an estimation method based on a functional unit, on weights and on calculation assumptions. But the development of methods for evaluating the useful life will also be based on basic assumptions which may, in turn, be called into question. It is therefore unrealistic to think of escaping the imperfections of environmental analysis by implementing a durability display. To assess the environmental impact of products, it is necessary to know their lifespan. For instance, in the case two similar products, if t-shirt “A” has a lifespan twice as long as t-shirt “B”, then for a given functional unit (e.g. 50 washes), the environmental impact of “B” will be twice as large as that of “A”. Currently though, there is no universally agreed standard for assessing accurately product lifespans.

Unlike decisions taken out of ecological consciousness, the financial aspect is very often the decision-making parameter of the consumer. Thus, the impact of displaying a lifetime of a product could be much greater than an environmental indication. For instance, by offering to directly display the cost of using the product, e.g. a piece of furniture designed to last 5 years and sold for 100 EUR, would actually cost 20 EUR per year. In addition, potential water consumption, electricity, or other consumables can also be taken into account in this use price. While the influence of such an approach on consumer choice could be considerable, the calculation of such a “use cost” could be complicated.

In practice, it is important to take care when choosing the design of a product’s lifetime label. For example, displaying the normative value of “Lifespan in normal use: 500 cycles” is not enough for producing the anticipated effects, but it must also be accompanied by related information campaigns for educating the consumer in reading and understanding the label. The displayed value on the label does not necessarily reflect the consumer’s conditions of use. Also, it should be noted that the standard life of a product does not take into account the availability of spare parts and therefore would not necessarily reflect the reality in terms of operating life. The normative duration just makes it possible to compare two products with each other.

It is also necessary to avoid that this normative life is expressed in number of years but rather in number of operating hours or number of cycles. Consumers could confuse it with the concepts of legal warranty or manufacturer’s warranty (also expressed in number of years), and thus feel frustrated if their product breaks down before the period indicated. The consumer should not understand that after the indicated time, the product is obsolete. It is therefore a matter of communicating in an educational way towards the consumer. For instance, this could take the form of a brief documentation, inside the packaging of the products.

On the other hand, the credibility of a normative display of lifespan, in the form of number of years, could very quickly be questioned by consumers. They might get frustrated if one of their products does not reach the stated shelf life. For this reason, it would be beneficial to include further considerations in a durability label that could express durability through criteria of availability of spare parts, repairability and by taking into account the evolutionary aspect of products.

This would provide a more accurate picture of the effective longevity of the product. For the implementation of such a label, it would be necessary to work with all the stakeholders on the development of methods and criteria. However, discussions with traders demonstrated that although in principle this is a good idea for consumers, it may not be embraced by manufacturers who would see labelling lifespan as a threat to existing business models. For labelling to happen, manufacturers need to see durability as a competitive advantage and commercially viable.[314]

Looking at how durability information can be effectively provided to consumers, a European study[315] concluded that consumers prefer to receive durability information either as a manufacturer warranty or expected lifetime indication. Showing durability information as part of an existing EU label was slightly less effective. When durability information on an EU label was shown in conjunction with repairability information, it was less effective compared to the other ways of providing durability information. The group of respondents who saw durability information together with repairability information chose on average less durable products compared to respondents who saw durability information on its own. But respondents who saw durability and repairability information together still chose product with higher average durability than the respondents who did not see any durability information.

Specifically, participants welcomed the idea of being provided with information about the durability of products and agreed that this should be presented on product labels or in the shop at the time of purchase (or on the website, if a product is purchased online). Some suggested that sales staff should also be able to inform customers about a product's durability. Attitudes towards the suggestion of having the information presented on the EU Energy Efficiency Label (or as a similar label) were very positive. Participants felt that this would enable displaying products' durability in a simple, straightforward manner, and would enable consumers to easily compare products.

Participants also made suggestions on how durability should be defined for each of the different products:

- Washing machine/dishwasher: estimated number of washes (rather than number of years). Participants agreed that for these products, expressing durability in number of years would not be accurate, because some households use these more often than others.
- Television: estimated number of years or estimated number of hours of use, because the frequency of use for this type of product varies by household. Another suggestion was to combine information on number of years with the average number of hours of use per day.
- Vacuum cleaners: estimated number of hours of use.
- Smartphones: some participants suggested number of years, others also suggested number of battery charges. Some mentioned that it would be helpful to have an indication of the battery's durability in number hours (and the equivalent in number of years) because this is often the part that breaks down first.

314 Knight et al., 2013.

315 LE Europe, 2018.

7.4.4 Spill-over effects

Irrespective of the environmental aspects or type of impacts presented on a label and the design/mode of information displayed, prior exposure to environmental labels creates a cognitive precedence in consumers' decision-making process. This phenomenon has been described as label information spill-over effects. A study[316] on behalf of the European Commission identified spill-over effects, and presented two distinctive types of spill-over effects:

1. The tendency of people to adopt a similar mind-set to a different situation after seeing an energy label.
2. The second type refers to the extent to which effective elements in the label for one product can also be used in labels for another product.

To provide some initial insight into the presence of spill-over effects of the labels to environmental concerns the study examined the differences in respondents' general environmental concern after exposure to energy information in the simulated shopping experiment. Consumer decision process depends on factors such as goals, consequences of right or wrong choice, available time, motivation and ability to weigh information.

It was demonstrated in the study that labels help consumers to understand relatively complicated characteristics of products and facilitate the choice process. This is particularly relevant when consumers are (cognitively) unwilling or unable to take all relevant information into account. The less willing or capable consumers are to process all the available information, the easier the information should be presented in order to have an impact on the consumer decision making.

For example, energy related information in the form of colour scaling and letters identifying the energy class (e.g. EU energy label) was found to be the most effective. However, whether this can inform label design for other product categories would depend on the type of product, as well as the attribute (energy efficiency or another attribute) to be communicated as consumers come to understand labels. Although exposure to a label similar to the EU energy label would make immediately recognizable the scale of measurement and perception of "right" or "wrong" choice, it might confuse the consumer as to what attribute of the product it is measuring. Therefore, spill-over effects condition consumers to identify easily and rank accordingly a set of product attributes, however the challenge of a potential label is to effectively communicate the specific attribute without confusing the consumer.

316 Leenheer et al., *Study on the effects on consumer behaviour of online sustainability information displays*, 2014.

8 Existing and proposed policies to extend product lifetimes: a review of advantages and drawbacks of different policy instruments

This chapter discusses the main advantages and shortcomings associated with various policy instruments that can be used to promote longer lifetimes of products. It also discusses which policies are of greater importance, and some implications for a potential policy mix. Finally, some 'dynamic' parameters that may be very important to consider, that can change the context for policymaking, are discussed. This chapter is based on the authors' own analysis of the literature.

8.1 Strengths and weaknesses of current and proposed policy instruments

Generally speaking, if there was a 'green tax reform' – which would increase the price of materials and reduce the costs of labour – some of the challenges related to stimulating longer lifetimes and repairs would be resolved. Products would become more expensive and repair would become cheaper, without the need for other types of interventions. But since we have talked about such a reform for 30 years, and no EU country has been able to make any significant progress, we will focus on more realistic policy choices. The main policies that can be used to induce longer product lifetimes and/or increased repairs, are provided in Figure 9.

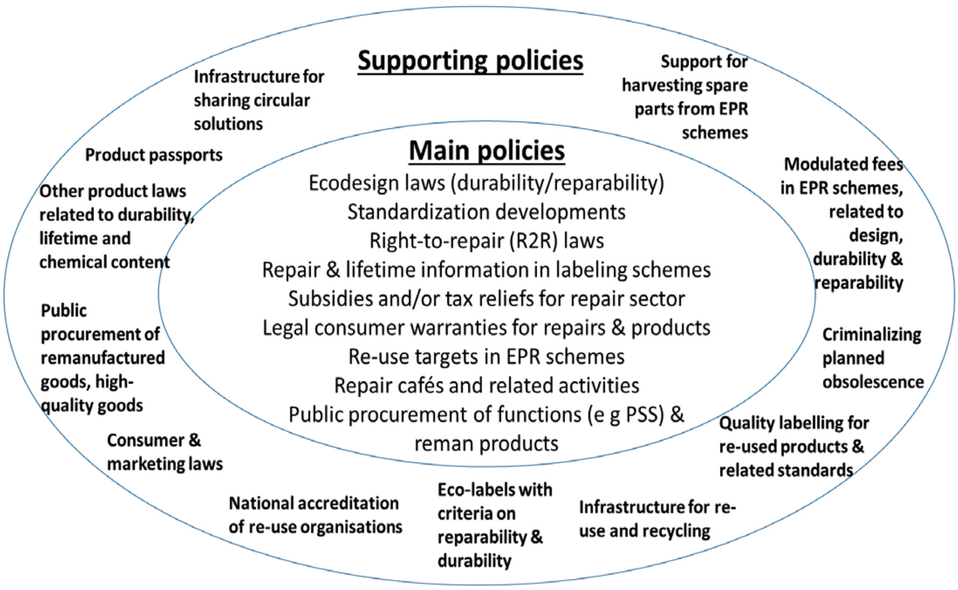

Figure 9. The variety of policies that can be used to induce longer product lifetimes and/or increased repairs.

'Main policies' are those policies that can directly provide incentives for designing long-life products and repair them, whereas 'supporting policies' are policies which (a) we believe will – at least in the short term – provide quite weak incentives for such changes , or (b) are not directly addressing lifetime/repairs but may nevertheless support such developments.

In table 20 we discuss the main policies, at which 'policy level' they should be applied, their main potential contributions to longer lifetimes and/or repairs, and some concerns related to their current applications.

Table 20. Discussion of the main policies about their level of implementation, main potential contributions to longer lifetimes/repairs and related implications.

Policy	Policy level	Potential	Shortcomings in current application
Ecodesign Directive	EU (legal harmonization)	High potential to induce durable design, design for repairability, and 'right-to-repair' obligations	Current standards focus more on repairability than lifespan per se. If regulating durability, testing will be problematic for very durable products Affluent consumers have little patience for repairs for some products; not certain current rules will address this. Some product groups (e.g. textiles, furniture) may not be suitable to address through the Ecodesign Directive. Then, product specific regulations could be an option. The need to set product-specific regulations, and to specify product components related to design solutions, means that it could be a cumbersome approach to achieve change.
Standardization	International/ EU	Necessary for measuring, regulating and communicating durability and repairability	Uncertain how much support generic standards can provide. Policy measures need to be product-group specific.
Right-to-repair (R2R) laws and policies (rights for consumers to go to independent repairers; right for independent repairers to access tools, spare parts and manuals etc.)	EU/national. Several US states have proposed R2R laws. The EU has set related requirements from some product groups under the Ecodesign Dir.	Necessary in order to stop OEMs from using IPRs as barrier for repairs.	Significant resistance from OEMs makes it difficult to adopt laws despite popular support; especially in the US. OEMs may find some loopholes' or adopt business strategies to circumvent rules.

Policy	Policy level	Potential	Shortcomings in current application
Repair & lifetime information in labelling schemes	EU for mandatory schemes/EU Ecolabel National/regional for other eco-labelling schemes	Very important: can be used as benchmarks by producers and consumers; may lead to other changes in consumers' use of information	It can be problematic to set such requirements as what constitutes 'lifetime' and the factors affecting lifetime may differ between product groups and be quite complex. Durability and repairability is affected also be e.g. software updates; thus a holistic approach is required
Subsidies and/or tax reliefs for repair sector	National/regional	Can support the sector, which is currently struggling with low profit margins (for many product groups, not all)	May be problematic due to rules on subsidies and other competition concerns. Alternatives may involve tax deductions and other approaches. Taxes are primarily a national issue, and thus such measures will not cover the whole EU.
Legal consumer warranties for repairs & products (guarantees per se, but also rules on 'burden of proof')	Mainly national law (also EU consumer law, minimum harmonisation)	Potentially very strong incentive to promote more durable products	There are many uncertainties regarding effects on the market. It is not known if this provides a strong incentive for ecodesign among OEMs, and neither if consumers will use the rules to make redress for faulty products. Consumers are often confused regarding legal guarantees vs. OEM warranties etc. The rules on 'burden of proof' is at least as important as the legal guarantee.
Re-use targets in EPR schemes	EU and national policy	Re-use targets would support re-use of products and harvesting of spare parts; when there are only recycling targets there are limited (or no) incentives to take good care of collected goods	Re-use targets would be a start, but several other issues should be resolved such as: • The role of OEMs and the potential for other actors to make use of the products • Liabilities, guarantees and ownership issues
Repair cafés and related activities	Regional/local, possibly supported by national/EU policies	Helps to nurture 'repair culture' and make repair more trendy	Hard to scale up such activities in all regions. Heavily dependent upon consumer interest. Will need some public funding and information campaigns
Public procurement of functions (e.g. PSS) & remanufactured products	Local/regional/ National; can be supported by national and/or EU guidelines etc.	High potential for some remanufactured products, such as ICT/furniture. High potential in procuring functions in some areas as it changes the incentives for OEMs.	Procuring remanufactured products often hindered by attitudes and existing practices. Many procurers do not feel convenient with procuring functions and it entails certain risk cf. to traditional procurement.

Regarding 'supporting policies' these either provide indirect support, or – we believe – have limited steering potential in the short term. Some interesting support policies are:

- *Modulated fees in EPR schemes*: These have potential to provide incentives for ecodesign, but research from France shows that current fees on durability/repairability have had limited effect.[317] In order to provide incentives there is a need to raise the amount of bonus/malus[318], and to apply similar types of fees around Europe[319] to provide a greater influence on OEMs.
- *Infrastructure for re-use and recycling/ Support for harvesting spare parts from EPR schemes*: there is significant potential for re-use of some EOL products[320], and to harvest high-quality spare parts from EOL streams. This could significantly reduce the costs of repairs. Currently, EPR targets in legislation are only set on weight-based collection and recycling, which can favour shredding for easy recovery of basic metals over recovery of components that may require manual labour. Reuse of components can be incentivised through more qualitative requirements for recycling in EPR policies as well as incentives to reuse such components. But several legal and organization barriers must then be overcome.[321]
- *Quality labelling for re-used products & related standards*: credible labelling schemes can be very important as they increase consumer confidence for reconditioned products and can reinforce public purchasing by providing relevant information.[322]
- *Public procurement of high-quality goods:* Increasing volumes of high-quality goods is beneficial, as they last longer and have higher potential for re-use and remanufacturing than products of lower quality.[323]
- *Public procurement of remanufactured goods:* Procurement of larger number of remanufactured products can support the remanufacturing industry in scaling up[324], which will be beneficial also for consumer markets.

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317 Micheaux and Aggeri, Eco-modulation as a driver for ecodesign: A dynamic view of the French collective EPR scheme, *Journal of Cleaner Production*, vol.289 (2021), 125714.

318 Ibid

319 Kunz et al., Stakeholder Views on Extended Producer Responsibility and the Circular Economy, *California Management Review*, vol. 60 (2018), 45–70.

320 Milios and Dalhammar, Ascending the waste hierarchy: re-use potential in Swedish recycling centres, *Detritus*, vol. 9 (2020), 27–37.

321 Dalhammar et al., 2020a.

322 Gåvertsson et al., 2020.

323 Crafoord et al., The use of public procurement to incentivize longer lifetime and remanufacturing of computers. *Procedia CIRP*, vol. 73 (2018), 137–141.

324 Öhgren et al., Public procurement of remanufactured furniture and the potential for procuring product-service systems (PSS) solutions. *Procedia CIRP*, vol. 83 (2019), 151–156.

8.2 The policy mix

The necessary policy mix for promoting longer lifetimes and repairs includes both EU policies, national policies, and policies that can be influenced by both EU and national policies. Some key policies are outlined below.

Mainly EU policies

- Ecodesign requirements for durable quality products that are easy to repair and disassemble.
- Information requirements to consumers about the expected lifetime and repairability.
- Obligation to produce, and right to access, spare parts/tools/repair information at reasonable costs, for consumers and/or independent repairers.

EU and/or national policies

- Extended legal guarantees and burden of proof on producers for new products.
- Legal guarantees on repairs.
- Removal of legal barriers to repair (e.g. copyright and patent).
- Labelling schemes to guarantee the quality of repaired or remanufactured products.
- Requirements to offer repair services and take-back in store.

Mainly national rules

- Subsidies to some repair activities, and/or tax deductions for repairs.[325]
- Requirements about durability and repairability in public procurement rules and tenders, and appropriate training to public actors to identify and promote resource efficient solutions in public purchasing.
- Funding/supporting repair cafés and activities to raise awareness.

A key issue moving forward concerns the relationship between EU member states' policies and EU policies. A *'dynamic'* policy field requires new policy developments at both the EU and national levels, whereas considerations about the Internal Market and fair competition necessitates some harmonization of measures at the EU level. Also, in relation to policies where EU member states have some discretion, there could be a need for some coordination of measures.[326]

Sweden should consider developing national policies in some arenas, including public procurement, support to the repair sector, and infrastructure and support for re-use, repair and second hand.

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[325] The best approach would be to take a more holistic approach to the taxation framework for the Circular Economy; see e.g. Milios, Towards a Circular Economy Taxation Framework: Expectations and Challenges of Implementation. *Circular Economy and Sustainability*, 2021. https://doi.org/10.1007/s43615-020-00002-z

[326] One examples concerns modules fees: member states decide over the fees, but the WFD indicates that some level of harmonization may be necessary; cf. WFD Art. 8 and Recital 27.

8.3 Dynamic parameters

There is a number of market conditions that could significantly change some of the dynamics on the market, and therefore also the case for new policies. These include:

- *More high-quality, expensive products*: some of the policies outlined above could lead to an increase in products prices and product quality. This would be beneficial, as it would lead to more careful consideration of purchases among consumers, and to them seeing products as valuable commodities that could be repaired and upgraded.
- *More servitization*: There are currently projects testing the leasing of products to customers, as alternative to traditional sales. This would change the way OEMs profit from a product and could lead to ecodesign development. If such activities could be replicated and reach a critical mass, it may further support changes in both ecodesign and consumer offerings.
- *Consumer attitudes and habits*: some policies, like lifetime labelling of products could change consumer attitudes, and eventually also influence purchasing decisions. Consumers would probably be increasingly willing to pay a premium for longer product lifetime as they are "educated" in thinking about these issues.
- *Price of spare parts and spare part harvesting*: Remanufacturing of spare parts from cars is an expanding business. Actors like insurance companies have supported this trend as it reduces costs of repairs. There is potential to harvest spare parts from high-quality OEM products, and manufacture them or directly use them in repairs, if the barriers for such practices can be overcome. This could lead to lower costs for repairs.
- *Subsidies and education for the repair sector*: the repair sector related to some consumer products is struggling with low profit margins and lack of educated repairers. Direct government subsides, and educational efforts, under a limited period, could be one way to provide a boost for the sector. If the sector scales up, the profit margins are likely to rise.
- *Training and education in the public sector:* Public officials in procurement services need to be equipped with the appropriate set of skills and competencies to allow the identification and handling of resource efficiency criteria in procurement tenders. Training and education of public procurers is critical for the future development of procurement criteria and contracting conditions that reflect the demand for longer life of products. This could help overcome the current resistance towards purchasing 'functions' instead of products.[327]
- *Systemic change*: Concluding, there are several interesting avenues for inducing changes in the systems. In order to realize the vision of a circular economy, it will be crucial to adopt a systems perspective, in order to ensure that resources can be accessed by actors that can realize its value, with proper policies to support these processes.

[327] Sveriges Offentliga Inköpare, *Universitetsutbildning i offentlig upphandling på gång?*, 2018. https://www.soi.se/aktuellt/2018/februari/universitetsutbildning-linkoping

9 Conclusions and ways forward

This chapter draws some conclusions, and discusses the potential ways forward regarding polices for longer product lifetimes and more product repairs.

9.1 Conclusions

The main conclusions of the study include the following:

- There are currently a lot of barriers that obstruct the development towards longer product lifetimes and more consumer repairs. Key barriers include product designs, legal barriers for repairs, and the rather low price of resources and high cost of labour.
- In order to overcome existing barriers, a policy mix is needed. There are currently a lot of policy initiatives which aim to increase the lifespan of products, through product design, re-use and remanufacturing etc. They are adopted both by the EU and its member states (including at regional and municipal levels). Key policies include the Ecodesign Directive, changes in consumer laws, and labelling initiatives. France has adopted policies like modulated fees in producer responsibility schemes, repairability label (as of 2021, 5 product groups are regulated), and plans to introduce a durability label and a repair fund. We can expect other countries to adopt similar policies, but also new ones. We can also expect the EU to adopt similar policies and harmonize market requirements, as well as introduce new EU policies like 'product passports'. While all these new policy developments are welcome and necessary, it is questionable if they can overcome all the barriers for long-lived, repairable products identified in this study, and we can therefore expect additional policies in the future.
- The vocabulary and definitions around product lifetimes and related concepts (technical lifetime, premature obsolescence etc.) leads to some confusion and can be a barrier for new policy developments. A number of standards are being developed, which aims to standardize some vocabulary. There is also a new generation of standards that can support new policies and laws related to durability, product lifetime and repairability. That being said, different product groups may require different measures and approaches, depending on issues like the profile of the life cycle environmental impacts, user behaviour, technical maturity etc.
- The number of product oriented environmental and waste policies are growing. This means that it is increasingly important to analyse how these policies interact. Clearly some policies have 'synergistic' effects, i.e. they work well together. But there is an increasing recognition that some policies may be in conflict with each other, and in literature there is an increasing number of examples of such conflicts. For example, rules related to chemicals in products – adopted to support toxic-free material streams – can be a barrier for repair and remanufacturing. Thus, issues related to 'policy coordination', 'policy integration' and 'policy harmonization' are of increasing importance. Further, as long as producers and consumers do not have to pay for all environmental impacts (externalities) associated with products, the more sustainable alternatives may be more expensive.

- The majority of LCA studies and other studies on product lifetimes are devoted to EEE. Further, due to the scope of the Ecodesign Directive most of the studies are devoted to energy-related products. It is important that other product groups, such as furniture and textiles are not "forgotten". There are several proposals and readily available ideas in literature on how to regulate such product groups.[328]
- There are some regulations under the Ecodesign directive that relates to product lifetime, but the most recent regulations are focused more on "repairability" than product lifetime *per se*. There can be good reasons for why this is the case, but it is likely that it is better to ensure that products last longer than that they are repairable in case they break down. Product breakdown is a failure in itself, and all broken products will not be repaired.
- LCA studies can provide some ideas on "optimal lifetimes" from an environmental perspective. However, we should remember that there can be other reasons for striving for longer product lifetimes. Longer lifetime is one important aspect of "product quality" and high quality can make consumers more trustful of new types of products and technologies. Further, consumers may want longer-lived products for economic reasons.
- Energy-using products, having significant environmental impacts typically in their use stage, generally have trade-offs that need to be considered. The optimal lifetimes for these products depend on the following factors: the energy context in which they are produced and used, the intensity of use, the efficiency of the base product, the rate of product development for products with highest impacts in use stage, the efficiency of the replacement, and actual user replacement patterns. The trade-offs between various environmental parameters are likely to be reduced over time: As product development matures and electricity mixes are decarbonized, most products should be used as long as possible and increases in lifetime will result in lower environmental impacts.
- For products with most environmental impacts in the production stage, like computers, TVs, phones, furniture and clothing, increasing product lifetimes results in significantly less environmental impacts regardless of electricity context and even with consideration of any energy and material inputs of repairs and modular designs. Modularity and upgradability are key enablers to extending the *functional* lifetime of these products, as consumer needs and demands change.
- Information about product durability can increase consumers' willingness to pay for more durable products, as durability is among the top three most important factors for consumers when buying a product.
- Durability labelling can be an effective way to inform consumer choices in the marketplace, but the increasing number and diversity of different labelling systems can create confusion. Therefore, a durability labelling must be designed in a way that is widely understood by the public and be able to instil a sense of trust to the consumers. The information must send a clear signal and encourage "environmentally positive" behaviour, taking into account the specificities of different demographic groups (e.g. depending on gender, age and level of education).

[328] Bauer et al., *Potential Ecodesign Requirements for Textiles and Furniture*, 2018.

- A one-size-fits-all horizontal approach as regards product lifetime is unlikely to be appropriate – different approaches are suitable to different products at different times. Even for the same product, different approaches may be needed over time in response to market evolution and technological evolution.
- The most appropriate way to express the life of products is not in number of years, as this may confuse consumers in relation to its legal guarantees (according to the Consumer Purchase Act) and commercial guarantees, which are expressed is years. A more fitting approach is to use the 'number of operating hours' or 'number of cycles' of products. Currently though, there is no universally agreed standard for assessing accurately product lifespans. A recent proposal suggests the introduction of a 'usage meter' (similar to the well-known odometer which is installed in cars), that could count the number of hours of use (e.g. in TVs, smartphones, laptops etc.) or the cycles of use (e.g. for washing machines, dishwashers etc.). This meter would give objective information on the product lifetime throughout its use.[329]
- Finally, for the effective application of labelling initiatives it is important to provide in parallel relevant educational information so that consumers can absorb the message and use the labelling in a good way.

9.2 The ways forward

Given that this is a fast-moving policy area, it is not possible to provide any detailed recommendations on how Sweden and Europe should move forward with policies to increase product lifetimes and repairs. However, some issues should be considered, such as:

- The study has some implications for future rules related to ecodesign. A first implication is that many new standards under the Ecodesign Directive focuses on 'repairability', but consumers are more interested in 'durability'. Further, as consumers experience barriers that impede repairs, ecodesign standards related to durability provides more 'certainty' that products will be used longer than standards related to repairability. Thus, future ecodesign regulations should preferably apply more standards related to durability.
- Future ecodesign standards for mature product groups should strive for high-quality products, but also consider if ecodesign standards can support other design strategies, including modularity and upgradeability. It is important to pursue such strategies even if they are challenged by some industries. Research indicates that new standards are always resisted as they create uncertainty, but that industry tend to cope quite well over time. That being said, the Ecodesign Directive cannot always be the policy tool used to reach all kinds of policy objectives; there are instances when other policies are more appropriate.
- In Sweden, there has been a lot of focus on consumer products in policymaking, but there is a lot of potential also in the B2B sectors. Thus, these sectors, and products that are mainly sold in B2B relationships, should not be forgotten. Circular business models, such as functional sales, are also increasingly adopted in B2B, but are less popular in consumer markets. Thus, the potential for progressive solutions can be bigger in B2B markets.

[329] HOP, *Durable and repairable products: 20 steps to a sustainable Europe – White Paper*, 2020.

- From a macro level perspective, there are certain policies that may support longer product lifetimes and resource efficiency improvements in all sectors, whereas several sectors and product groups are in need of specific policy packages to overcome inertia. This is explored for five industrial sectors in a recent article.[330] Drawing from the conclusions of this research, certain wide, cross-sectoral policy measures are considered crucial, such as (1) public procurement for resource efficient products and services, (2) increased provision and access to information and (3) governmental leadership, setting mandatory re-use targets.
- An important issue concerns how "adventurous" Sweden should be when it comes to adopting national Swedish policies. On the one hand, the most important policy developments will take place at the EU level, but at the same time some countries – such as France – has shown a willingness to explore new national policies. The French examples includes the repairability index and modulated fees in producer responsibility schemes. In contrast, the Swedish Action Plan for Circular Economy seems to indicate more modest ambitions for policies for product lifetime and repairs – despite more progressive suggestions[331] from Swedish actors. If Sweden wants to be a leader in this area, it should explore more policy avenues. The introduction of a repairability scoring system for the Swedish market could be a possible suggestion, since there is the French example already in place[332], and much background research for its implementation exists in literature.[333]
- There is, rightly, a lot of focus on policies such as public procurement. However, while the potential of procurement is large, it is not always easy to realize it. Therefore, other policies should also be explored, and the policy mix needs to be widened to increase the potential of synergies between complementing policies (both existing and new innovative policies).
- For instance, Sweden is one of the first countries that has introduced reduced VAT rates for the repair of certain products (e.g. bicycles and shoes).[334] It is important to evaluate the effectiveness of this tax incentive and reinforce its use. Potentially, the scope of this policy instrument may be expanded to more product groups.[335]
- There is a strong focus on the regulation of energy-related products under the Ecodesign Directive. However, there are several other product groups with significant environmental impacts, e.g. textiles, furniture, plastics etc. Gradually, there needs to be a shift of focus towards such products as well and potentially introduce mandatory ecodesign requirements. Recent examples of potential ecodesign requirements related to durability include furniture and textiles.[336] The EU is currently looking into this under the Sustainable Products Initiative.[337]

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330 Milios, Overarching policy framework for product life extension in a circular economy – A bottom-up business perspective. *Environmental Policy and Governance*, 2021. https://doi.org/10.1002/eet.1927

331 Delegationen för cirkulär ekonomi, *Inspel till regeringens nationella strategi för cirkulär ekonomi*, 2019; https://www.svd.se/dags-att-fasa-ut-billiga-undermaliga-prylar ;

332 HOP, *Durable and repairable products: 20 steps to a sustainable Europe – White Paper*, 2020.

333 Cordella et al., 2019.

334 Milios, 2018.

335 Dalhammar (ed.) and Richter (ed), 2020.

336 Bauer et al., 2018.

337 European Commission, Sustainable Products Initiative, https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12567-Sustainable-products-initiative_en

- Regarding the purchase and use of products, a critical parameter that influences people's consumer behaviour is exposure to advertising. Marketing and advertising are the driving force behind cultural obsolescence, promoting early renewals of products even when they are still functional. Consumers cannot, on the one hand, be told to make better choices for the environment and on the other hand, be targeted by excessive advertising promoting repetitive/increased consumption. For this reason, there is a need for a more 'balanced' regulatory and operating landscape of advertising. Recent proposals[338] for regulating this area include: (1) the introduction of an obligation for advertisers to mention repair, reuse and more generally the second life of products, as well as recycling opportunities of the products they advertise; (2) the regulation of green claims in advertising and marketing to avoid greenwashing by banning the use of certain wording that minimizes a product's impact on the environment; and (3) imposing the display of environmental indicators in advertising (such as ecolabels etc.).

[338] HOP, *Durable and repairable products: 20 steps to a sustainable Europe – White Paper*, 2020.

References

AEA Energy & Environment, *Work on Preparatory Studies for Ecodesign Requirements of EuPs (II) Lot 17 Vacuum Cleaners*, 2009. Report to European Commission. https://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Arbeitsplan/eup_lot17_final_report_issue_1.pdf (accessed 2021-02-17).

Ajzen, Icek, The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, vol. 50 (1991), 179–211.

Alaranta, Joonas et al., How to Reach a Safe Circular Economy? – Perspectives on Reconciling the Waste, Product and Chemicals Regulation, *Journal of Environmental Law*, 2020. doi: https://doi.org/10.1093/jel/eqaa016

Albertsen, Levke, *Circular Business Models for Electric Vehicle Lithium-Ion Batteries: An analysis of current practices of vehicle manufacturers in the EU and the potential for innovation at Volvo Group*, Diss., Lund: Lund University, 2020. http://lup.lub.lu.se/student-papers/record/9017546

Ambrose, Hanjiro et al., Trends in life cycle greenhouse gas emissions of future light duty electric vehicles. *Transportation Research Part D: Transport and Environment*, vol. 81 (2020), 102287.

Amend, C. et al., Modularity, Design, and Circularity. A Review, in *Proceedings of the IS4CE2020 Conference of the International Society for the Circular Economy*, 6–7 July 2020, Exeter: University of Exeter, 2020.

André, Hampus et al., Resource and environmental impacts of using second-hand laptop computers: A case study of commercial reuse. *Waste Management*, vol. 88 (2019), 268–279.

Antonides, Gerrit, An economic-psychological model of scrapping behavior. *Journal of Economic Psychology*, vol. 12 (1991), 357–379.

Ardente, Fulvio and Mathieux, Fabrice, Environmental assessment of the durability of energy-using products: Method and application. *Journal of Cleaner Production*, vol. 74 (2014), 62–73.

Bakker, Conny et al., Products that go round: Exploring product life extension through design. *Journal of Cleaner Production*, vol. 69 (2014), 10–16.

Bakker, Conny and Schuit, Cheyenne, The Long View: Exploring Product Lifetime Extension, United Nations Environment Programme, 2017. https://www.oneplanetnetwork.org/sites/default/files/the_long_view_2017.pdf (accessed 2021-02-17).

Bauer, Bjørn et al., *Potential Ecodesign Requirements for Textiles and Furniture*. TemaNord:2018:535, Copenhagen, Nordic Council of Ministers, 2018.

Baxter, John, Systematic environmental assessment of end-of-life pathways for domestic refrigerators. *Journal of Cleaner Production*, vol. 208 (2019), 612–620.

Bobba, Silvia et al., *Technical support for Environmental Footprinting, material efficiency in product policy and the European Platform on LCA – Durability assessment of vacuum cleaners*. Luxembourg: Publications Office of the European Union, 2015. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC96942/lb-na-27512-en-n_.pdf (accessed 2021-02-17).

Bobba, Silvia et al., Environmental and economic assessment of durability of energy-using products: Method and application to a case-study vacuum cleaner. *Journal of Cleaner Production*, vol. 137 (2016), 762–776.

Boldoczki, Sandra et al., The environmental impacts of preparation for reuse: A case study of WEEE reuse in Germany. *Journal of Cleaner Production*, vol. 252 (2020), 119736.

Boulos, Stephanie et al., *The Durability of Products – Standard assessment for the circular economy under the Eco-Innovation Action Plan*, Report for the European Commission DG Environment, Harwell: Ricardo-AEA Ltd, 2015.

Bovea, Maria D. et al., Variables that affect the environmental performance of small electrical and electronic equipment. Methodology and case study. *Journal of Cleaner Production*, vol. 203 (2018), 1067–1084.

Bovea, Maria D. et al., Repair vs. replacement: Selection of the best end-of-life scenario for small household electric and electronic equipment based on life cycle assessment. *Journal of Environmental Management*, vol. 254 (2020), 109679.

Boyer, Robert H.W. et al., Product Labels for the Circular Economy: Are Customers Willing to Pay for Circular? *Sustainable Production and Consumption*, vol. 27 (2021), 61–71.

Braithwaite, Naomi et al., Should energy labels for washing machines be expanded to include a durability rating? In *PLATE 2015 Conference Proceedings*, 2015. http://irep.ntu.ac.uk/id/eprint/8546/1/220134_PubSub2377_Moreno.pdf (accessed 2021-02-17).

Brocklehurst, Fiona et al., Can the provision of energy and resource efficiency information influence what consumers buy? A review of the evidence, in *ECEEE 2019 Summer Study on Energy Efficiency: Is Efficient Sufficient?* (pp. 1621–1630), 2019.

Brönneke, Tobias, Premature Obsolescence: Suggestions for Legislative Counter-measures in German and European Sales & Consumer Law. *Journal for European Environmental & Planning Law*, 14 (2017), 361–372.

Burns, Brian, Re-evaluating obsolescence and planning for it. In T. Cooper (Ed.), *Longer lasting products – Alternatives to the throwaway society* (pp. 39–60). Farnham, UK: Gower, 2010.

Böckin, Daniel et al., How product characteristics can guide measures for resource efficiency – A synthesis of assessment studies, *Resources, Conservation and Recycling*, vol. 154 (2020), 104582.

Casamayor, Jose et al., Extending the lifespan of LED-lighting products. *Architectural Engineering and Design Management*, vol. 11 (2015), 105–122.

CEN-CENELEC, *Standardization in a Circular Economy – Closing the Loop*, 2020. https://www.cencenelec.eu/news/publications/Publications/CEN-CENELECCircularEconomyAccess_rev2020-05-V1.pdf (accessed 2021-02-17).

Chen, James, Economic Life, *Investopedia*, 2020. https://www.investopedia.com/terms/e/economic-life.asp (accessed 2021-02-17).

Clément, Louis-Philippe P.-V.P. et al., Sources of variation in life cycle assessments of smartphones and tablet computers. *Environmental Impact Assessment Review*, vol. 84 (2020), 106416.

COM(2018) 32 final, *on the implementation of the circular economy package: options to address the interface between chemical, product and waste legislation*, European Commission.

COM(2020) 98 final, *A new Circular Economy Action Plan For a cleaner and more competitive Europe*, European Commission.

COM(2020) 696 final, *New Consumer Agenda – Strengthening consumer resilience for sustainable recovery*, European Commission.

COM(2020) 798/3, *Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020*, European Commission.

Cooper, Tim, Inadequate life? Evidence of consumer attitudes to product obsolescence. *Journal of Consumer Policy*, vol. 27 (2004), 421–449.

Cooper, Tim and Christer, Kirsty, Marketing durability, in T. Cooper (ed.), *Longer lasting products: alternatives to the throwaway society* (pp. 273–296). Farnham: Gower, 2010.

Cordella, Mauro et al., *Analysis and development of a scoring system for repair and upgrade of products – Final report*. Luxembourg: Publications Office of the European Union, 2019. http://publications.jrc.ec.europa.eu/repository/handle/JRC114337 (accessed 2021-02-17).

Cox, Jayne et al., Consumer understanding of product lifetimes. *Resources, Conservation and Recycling*, vol. 79 (2013), 21–29.

Crafoord, Katarina et al., The use of public procurement to incentivize longer lifetime and remanufacturing of computers. *Procedia CIRP*, vol. 73 (2018), 137–141.

Dalhammar, Carl, Industry attitudes towards ecodesign standards for improved resource efficiency, *Journal of Cleaner Production*, vol. 123 (2016), 155–166.

Dalhammar, Carl et al., Energy Efficiency Regulations, Market and Behavioural Failures and Standardization, in *Preventing Environmental Damage from Products – An Analysis of the Policy and Regulatory Framework in Europe*, Eléonore Maitre-Ekern (ed.), Carl Dalhammar (ed.), Hans Christian Bugge (ed.), p. 176–228, Cambridge: Cambridge University Press, 2018.

Dalhammar, Carl et al. Legal and organisational issues when connecting resource flows and actors: re-use and producer responsibility schemes for white goods, in *Proceedings of the IS4CE2020 Conference of the International Society for the Circular Economy*, 6–7 July 2020, Exeter: University of Exeter, 2020a

Dalhammar, Carl et al., Ecodesign and the Circular Economy: Conflicting Policies in Europe, in *EcoDesign and Sustainability: Products, Services, and Business Models*, Yusuke Kishita (ed.), Mitsutaka Matsumoto (ed.), Masato Inoue (ed.), Shinichi Fukushige (ed.), p. 187–198, Singapore: Springer, 2020b.

Dalhammar, Carl (ed.) and Richter, Jessika L. (ed.), *Promoting the Repair Sector in Sweden*, Lund: Lund University, 2020a.

Dávila, Marianna L., The *role of the consumer in the transition to a circular economy: Incentivizing electronics repair*. Student paper, Lund: Lund University, 2021.

Defra, *Public understanding of product lifetimes and durability (1)*, report to the Department for Environment, Food and Rural Affairs. London: Brook Lyndhurst, 2011. http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17254 (accessed 2021-02-17).

Delegationen för cirkulär ekonomi, *Slutrapport för Expertgruppen för cirkulära designprinciper*, 2020. https://www.delegationcirkularekonomi.se/download/18.79179b21176dc0a6fcb104e5/1610701974126/Slutrapport%20Expertgruppen%20for%20cirkula%CC%88ra%20designprinciper%20(tillg%C3%A4nglig)2.pdf (accessed 2021-02-17).

Deloitte, *Study on socioeconomic impacts of increased repairability, Final report*. Prepared for the European Commission. DG ENV, 2016. https://op.europa.eu/en/publication-detail/-/publication/c6865b39-2628-11e6-86d0-01aa75ed71a1/language-en (accessed 2021-02-17).

Devoldere, Tom et al., The eco-efficiency of reuse centres critically explored-the washing machine case. *International Journal of Sustainable Manufacturing*, vol. 1 (2009), 265–285.

Dragomir, Mihai et al., Dealing with component lifecycle disparity in smart furniture, in *Proceedings of the 3rd International Virtual Conference on Advanced Scientific Results*, 2015.

Dünnhoff, Elke and Palm, Alexandra, *Comprehensibility of the EU Energy Label – Results of two focus groups and a representative consumer survey*. Verbraucherzentrale Rheinland-Pfalz, 2014. https://www.verbraucherzentrale-rlp.de/sites/default/files/migration_files/media231718A.pdf (accessed 2021-02-17).

Echegaray, Fabián, Consumers' reactions to product obsolescence in emerging markets: The case of Brazil. *Journal of Cleaner Production*, vol. 134 (2016), 191–203.

EN 45552:2020 General method for the assessment of the durability of energy-related products.

EN 45554:2020 General methods for the assessment of the ability to repair, reuse and upgrade energy-related products

EN 45556:2019 General45556:2019 General method for assessing the proportion of reused components in energy-related products

EN 45553:2020 General method for the assessment of the ability to remanufacture energy-related products

European Commission, *The new ecodesign measures explained*, 2019. https://ec.europa.eu/commission/presscorner/detail/en/QANDA_19_5889 (accessed 2021-02-17).

Fangeat, Erwann and Chauvin, Clément, *Allongement de la durée de vie des produits*, ADEME Rapport (56p.), 2016. https://www.ademe.fr/allongement-duree-vie-produits (accessed 2021-02-17).

Frolov, Tobias, *Reuse of white goods components – An interview study on drivers, barriers, and the future outlook*, Diss., Lund: Lund University, 2020.

Gåvertsson, Ida et al., Quality Labelling for Re-used ICT Equipment to Support Consumer Choice in the Circular Economy. *Journal of Consumer Policy*, vol. 43 (2020), 353–377.

Gfk, *Consumer Market Study to support the Fitness Check of Consumer Rules*. Luxembourg: Publications Office of the European Union, 2017. http://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=59332 (accessed 2021-02-17).

Giddings, Joe and Lomas, Seb L., Why we need embodied carbon regulation now, *Architect's Journal*, 2020. https://www.architectsjournal.co.uk/news/opinion/%E2%80%8B-why-we-need-embodied-carbon-regulation-now (accessed 2021-02-17).

Gnanapragasam, Alex et al., Consumer perspectives on product lifetimes: a national study of lifetime satisfaction and purchasing factors, in *Product Lifetimes And The Environment 2017 Conference Proceedings,* p. 144–148, 2017.

Gruere, Guillaume P., An analysis of the growth in environmental labelling and information schemes. *Journal of Consumer Policy*, vol. 38 (2015), 1–18.

Guiltinan, Joseph, Creative Destruction and Destructive Creations: Environmental Ethics and Planned Obsolescence, *Journal of Business Ethics*, vol. 89 (2009), 19–28.

Hammond, Allen L. and Prahalad, C. K., Selling to the Poor, *Foreign Policy*, 2009. https://foreignpolicy.com/2009/10/27/selling-to-the-poor/ (accessed 2021-02-17).

Harmer, Luke et al., Design, Dirt and Disposal: Influences on the maintenance of vacuum cleaners. *Journal of Cleaner Production*, vol. 228 (2019), 1176–1186.

Harms, Rainer and Linton, Jonathan D., Willingness to Pay for Eco-Certified Refurbished Products: The Effects of Environmental Attitudes and Knowledge. *Journal of Industrial Ecology*, vol. 20 (2016), 893–904.

Hennies, Laura and Stamminger, Rainer, An empirical survey on the obsolescence of appliances in German households. *Resources, Conservation and Recycling*, vol. 112 (2016), 73–82.

Hervier, Marie et al., *Benchmark international du secteur de la réparation*. ADEME Rapport, 2018. https://www.ademe.fr/benchmark-international-secteur-reparation (accessed 2021-02-17).

HOP (Stop Planned Obsolescence), *Durable and repairable products: 20 steps to a sustainable Europe – White Paper*, 2020. https://www.halteobsolescence.org/wp-content/uploads/2020/11/Livre-Blanc-europeen.pdf (accessed 2021-02-17).

Horne, Ralph E., Limits to labels: The role of eco-labels in the assessment of product sustainability and routes to sustainable consumption. *International Journal of Consumer Studies*, vol. 33 (2009), 175–182.

Hughes, Richard, The EU Circular Economy Package – Life Cycle Thinking to Life Cycle Law? *Procedia CIRP*, vol. 61 (2017), 10–16.

Huisman, Jaco et al., *The Dutch WEEE flows*, Bonn: United Nations University, 2012.

Huulgaard, Rikke D. et al., Ecodesign requirements for televisions-is energy consumption in the use phase the only relevant requirement? The *International Journal of Life Cycle Assessment*, vol. 18 (2013), 1098–1105.

International Resource Panel, *Re-defining Value – The Manufacturing Revolution*, 2018. https://www.resourcepanel.org/reports/re-defining-value-manufacturing-revolution (accessed 2021-02-17).

Iraldo, Fabio et al., Is product durability better for environment and for economic efficiency? A comparative assessment applying LCA and LCC to two energy-intensive products. *Journal of Cleaner Production*, vol. 140 (2017), 1353–1364.

ISO/TR 14062:2002 Environmental management – Integrating environmental aspects into product design and development.

Jacobs, Kathleen, The Influence of Product Lifetime Labelling on Purchasing Electrical Appliances among German Consumers. Presented at the *Ecodesign Conference: The ecodesign directive and the circular economy: How can we move forward?* Brussels, 2018.

Kaddoura, Mohamad et al., Is Prolonging the Lifetime of Passive Durable Products a Low-Hanging Fruit of a Circular Economy? A Multiple Case Study. *Sustainability*, vol. 11 (2019), 4819.

Kahlin McVeigh, Mette et al., *Planned obsolescence – Built not to last*, Brussels: European Liberal Forum, 2019.

Keirsbilck, Bert et al., *Sustainable Consumption and Consumer Protection Legislation*, In-Depth Analysis for the Committee on Internal Market and Consumer Protection (IMCO), Policy Department for Economic, Scientific and Quality of Life Policies, Luxembourg: European Parliament, 2020.

Khan, Muztoba A. et al., Review on upgradability – A product lifetime extension strategy in the context of product service systems. *Journal of Cleaner Production*, vol. 204 (2018), 1154–1168.

Knight, Tim et al., *Electrical and electronic product design: product lifetime*. WRAP UK, 2013. http://www.wrap.org.uk/sites/files/wrap/WRAP%20longer%20product%20lifetimes.pdf (accessed 2020-12-12).

Kojima, Michikazu, Remanufacturing and Trade Regulation, *Procedia CIRP*, vol. 61 (2017), 641–644.

Kristoffersson, Peter, *Effekter av den svenska skatten på kemikalier i viss elektronik*, Diss., Lund: Lund University, 2019.

Kunz, Nathan et al., Stakeholder Views on Extended Producer Responsibility and the Circular Economy, *California Management Review*, vol. 60 (2018), 45–70.

Lancaster, Kelvin J., A New Approach to Consumer Theory. *Journal of Political Economy*, vol. 74 (1966), 132–157.

LE Europe et al., *Behavioural Study on Consumers' Engagement in the Circular Economy*. Brussels: European Commission, 2018. https://ec.europa.eu/info/sites/info/files/ec_circular_economy_final_report_0.pdf (accessed 2021-02-17).

Leenheer, Jorna et al., *Study on the effects on consumer behaviour of online sustainability information displays*. Final Report prepared for the European Commission Executive Agency for Health and Consumers, 2014. https://op.europa.eu/en/publication-detail/-/publication/87c863a3-88af-4c8a-ab47-beab72de492e (accessed 2021-02-17).

Leire, Charlotte and Thidell, Åke, Product-related environmental information to guide consumer purchases – A review and analysis of research on perceptions, understanding and use among Nordic consumers. *Journal of Cleaner Production*, vol. 13 (2005), 1061–1070.

Liu, Ran et al., State of the art in life cycle assessment of laptops and remaining challenges on the component level: The case of integrated circuits, in *Towards Life Cycle Sustainability Management,* p. 501–512, Springer, 2011.

Ljunggren Söderman, Maria and André, Hampus, Effects of circular measures on scarce metals in complex products – Case studies of electrical and electronic equipment. *Resources, Conservation and Recycling*, vol. 151 (2019), 104464.

Longmuss, Joerg and Poppe, Erik, Planned obsolescence: who are those planners?, in *Conference Proceedings Product Lifetimes And The Environment 2017*, Delft: Delft University of Technology, 2017.

Maitre-Ekern, Eléonore and Dalhammar, Carl, Regulating Planned Obsolescence: A Review of Legal Approaches to Increase Product Durability and Reparability in Europe, *Review of European, Comparative and International Environmental Law (RECIEL)*, vol. 25 (2016), 378–394.

Maitre-Ekern, Eléonore and Dalhammar, Carl, Towards a hierarchy of consumption behaviour in the circular economy, *Maastricht Journal of European and Comparative Law*, 2019. https://doi.org/10.1177/1023263X19840943

Makov, Tamar et al., What Affects the Secondhand Value of Smartphones: Evidence from eBay. *Journal of Industrial Ecology*, vol. 23 (2019), 549–559.

Mańko, Rafał, *Methods for unifying private law in the EU*, EPRS Briefings (No. 130628REV1), Brussels: European Parliament Research Service, 2014.

Marcus, Scott J et al., *Promoting product longevity*. Final Report for the European Parliament's Committee on the Internal Market and Consumer Protection (IMCO), 2020. https://www.europarl.europa.eu/committees/en/study-promoting-product-longevity-/product-details/20200417CAN54506 (accessed 2021-02-17).

Marwede, Max et al., Hide and seek – a systemic approach to sustainability in product development, in *Conference Proceedings Product Lifetimes And The Environment 2019*. Berlin: Technical University of Berlin, 2019.

McCollough, John, Factors impacting the demand for repair services of household products: the disappearing repair trades and the throwaway society. *International Journal of Consumer Studies*, vol. 33 (2009), 619–626.

McKenzie-Mohr, Doug and Smith, William, *Fostering sustainable behaviour – An introduction to community based social marketing*. Gabriola Island: New Society Publishers, 1999.

Micheaux, Helen, *Le retour du commun au coeur de l'action collective. Le cas de la responsabilité élargie du producteur comme processus de responsabilisation et de co-régulation*. Diss., Paris: Mines ParisTech, 2017.

Micheaux, Helen and Aggeri, Franck, Eco-modulation as a driver for ecodesign: A dynamic view of the French collective EPR scheme, *Journal of Cleaner Production*, vol.289 (2021), 125714.

Michel, Anaïs, Is there a need to legally define practices of premature obsolescence?, in *Conference Proceedings Product Lifetimes And The Environment 2019*. Berlin: Technical University of Berlin, 2019.

Milios, Leonidas, Advancing to a Circular Economy: three essential ingredients for a comprehensive policy mix, *Sustainability Science*, vol. 13 (2018), 861–878.

Milios, Leonidas, *Policy Framework for Material Resource Efficiency – Pathway Towards a Circular Economy*, Diss., Lund: Lund University, 2020.

Milios, Leonidas, Towards a Circular Economy Taxation Framework: Expectations and Challenges of Implementation. *Circular Economy and Sustainability*, 2021a. https://doi.org/10.1007/s43615-020-00002-z

Milios, Leonidas, Overarching policy framework for product life extension in a circular economy – A bottom-up business perspective. *Environmental Policy and Governance*, 2021b. https://doi.org/10.1002/eet.1927

Milios, Leonidas and Dalhammar, Carl, Ascending the waste hierarchy: re-use potential in Swedish recycling centres, *Detritus*, vol. 9 (2020), 27–37.

Mont, Oksana and Dalhammar, Carl, Sustainable consumption: at the cross-road of environmental and consumer policies. *International Journal of Sustainable Development*, vol. 8 (2005), 258-279.

Mont, Oksana and Power, Kate, The role of formal and informal forces in shaping consumption and implications for sustainable society: Part I. *Sustainability*, vol. 2 (2010), 2232–2252.

Mugge, Ruth et al., Design strategies to postpone consumers' product replacement: The value of a strong person-product relationship. *The Design Journal*, vol. 8 (2005), 38–48.

Murakami, Shinsuke et al., Lifespan of Commodities, Part I: The Creation of a Database and Its Review, *Journal of Industrial Ecology*, vol. 14 (2010), 598–612.

Muthu, Subramanian S., Environmental impacts of the use phase of the clothing life cycle, in *Handbook of Life Cycle Assessment (LCA) of Textiles and Clothing*, p. 93–102, Elsevier, 2015.

Nadvi, Khalid and Wältring, Frank, *Making Sense of Global Standards*, INEF – Institut für Entwicklung und Frieden, 2013. http://edoc.vifapol.de/opus/volltexte/2013/4549/ (accessed 2021-02-17).

Narendran, Nadarajah et al., Projecting LED product life based on application, in Proceedings Volume 9954, *Fifteenth International Conference on Solid State Lighting and LED-based Illumination Systems*, 2016. https://doi.org/10.1117/12.2240464

Naturvårdsverket, *Produkters livslängd och återvinningsbarhet – översiktlig beskrivning av befintlig kunskap*, 2020. https://www.naturvardsverket.se/upload/miljoarbete-i-samhallet/miljoarbete-i-sverige/regeringsuppdrag/2020/produkters-livslangd-och-atervinningsbarhet.pdf (accessed 2021-02-17).

Ní Choisdealbha, Á. and Lunn, P.D., Green and Simple: Disclosures on Eco-labels Interact with Situational Constraints in Consumer Choice. *Journal of Consumer Policy*, vol. 43 (2020), 699–722.

Nordelöf, Anders et al., Environmental impacts of hybrid, plug-in hybrid, and battery electric vehicles – What can we learn from life cycle assessment? *The International Journal of Life Cycle Assessment*, vol. 19 (2014), 1866–1890.

O'Connell, Maurice W. et al., Evaluating the sustainability potential of a white goods refurbishment program. *Sustainability Science*, vol. 8 (2013), 529–541.

Oguchi, Masahiro et al., Consumers' expectations for product lifetimes of consumer durables, in *Conference Proceedings Electronics Goes Green 2016+ (EGG)*, 2016. doi: https://doi.org/10.1109/EGG.2016.7829850

Packard, Vance, *The Waste Makers. A startling revelation of planned wastefulness and obsolescence in industry today*. NY: David Mckay Company, 1960.

Pehrsson, Victoria, *Hållbara telefoner inom verksamheter: En studie om användandet av mobiltelefoner hos företag och hur valet av mobil kan ske med hänsyn till hållbarhet*, Diss., Lund: Lund University, 2020.

Prakash, Siddharth et al., *Einfluss der Nutzungsdauer von Produkten auf ihre Umweltwirkung: Schaffung einer Informationsgrundlage und Entwicklung von Strategien gegen Obsoleszenz*, Dessau-Roßlau: Umweltbundesamt, 2016.

Prakash, Siddharth et al., *Timely replacement of a notebook under consideration of environmental aspects*. Report No.(UBA-FB), 1666, Dessau-Roßlau: Umweltbundesamt, 2012. https://www.umweltbundesamt.de/sites/default/files/medien/461/publikationen/4317.pdf (accessed 2021-02-17).

Proske, Marina et al., *Life cycle assessment of the Fairphone 2*, Berlin: Fraunhofer IZM, 2016.

Proske, Marina and Finkbeiner, Matthias, Obsolescence in LCA-methodological challenges and solution approaches. *The International Journal of Life Cycle Assessment*, vol. 25 (2020), 495–507.

Proske, Marina and Jaeger-Erben, Melanie, Decreasing obsolescence with modular smartphones? – An interdisciplinary perspective on lifecycles. *Journal of Cleaner Production*, vol. 223 (2019), 57–66.

Ramos, Belén and Fernández, Susana, *State-of-the-art existing testing, rating systems and standards*. Premature Obsolescence Multi-Stakeholder Product Testing Program (PROMT) – Deliverable 2.3, 2019. https://prompt-project.eu/wp-content/uploads/2020/07/PROMPT_20191220_State-of-the-art-existing-testing-rating-systems-and-standards.pdf (accessed 2021-02-17).

Rampell, Catherine, Planned Obsolescence, as Myth or Reality, *New York Times*, 2013. https://economix.blogs.nytimes.com/2013/10/31/planned-obsolescence-as-myth-or-reality/ (accessed 2021-02-17).

Regeringen, *Regleringsbrev för budgetåret 2020 avseende Statens energimyndighet*, 2019. https://www.esv.se/statsliggaren/regleringsbrev/?RBID=20349 (accessed 2021-02-17).

Regeringen, *Regleringsbrev för budgetåret 2021 avseende Statens energimyndighet*, 2020. https://www.esv.se/statsliggaren/regleringsbrev/?rbid=21184 (accessed 2021-02-17).

Regeringskansliet, *Cirkulär ekonomi – strategi för omställningen i Sverige*, 2020. https://www.regeringen.se/4a3baa/contentassets/619d1bb3588446deb6dac198f2fe4120/200814_ce_webb.pdf (accessed 2021-02-17).

Remmen, Arne et al., *Expanding the Scope of the EuP Directive*, TemaNord 2011:558, Copenhagen: Nordic Council of Ministers, 2011.

Richter, Jessika L., *Towards a Circular Economy with Environmental Product Policy: Considering dynamics in closing and slowing material loops for lighting products*, Diss., Lund: Lund University, 2019.

Richter, Jessika L. et al., Trade-offs with longer lifetimes? The case of LED lamps considering product development and energy contexts, *Journal of Cleaner Production*, vol. 226 (2019a), 195–209.

Richter, Jessika L. et al., Optimal durability in least life cycle cost methods: the case of LED lamps, *Energy Efficiency*, vol. 12 (2019b), 107–121.

Roos, Sandra et al., Will clothing be sustainable? Clarifying sustainable fashion, in *Textiles and clothing sustainability*, p. 1–45, Springer, 2017.

RREUSE, *Improving product reparability: policy options at the EU level*, 2015. http://www.rreuse.org/wp-content/uploads/Routes-to-Repair-RREUSE-final-report.pdf (accessed 2021-02-17).

Saavedra, Yovana et al., Remanufacturing in Brazil: Case Studies on the Automotive Sector, *Journal of Cleaner Production*, vol. 53 (2013), 267–276.

Schischke, Karsten et al., Modular products: Smartphone design from a circular economy perspective, in *Conference Proceedings Electronics Goes Green 2016+ (EGG)*, 2016. doi: https://doi.org/10.1109/EGG.2016.7829810 (accessed 2021-02-17).

Schlegel, Moritz-Caspar et al., Ecodesign spinning towards the circular economy – the contribution of new standards on material efficiency, in *Conference Proceedings Product Lifetimes And The Environment 2019*. Berlin: Technical University of Berlin, 2019.

Schmitz, Angelika, et al., Large Washing Machines Are Not Used Efficiently in Europe, *Tenside Surfactants Detergents*, vol. 53 (2016), 227–234.

Sevelius, Emilia, *Ökad plaståtervinning vs giftfria materialflöden – En analys av ändringen av POPs-förordningen*, Diss., Lund: Lund University, 2019.

Siderius, Hans-Paul, The role of experience curves for setting MEPS for appliances, *Energy Policy*, vol. 59 (2013), 762–772.

SIRCOME et al., *The influence of lifespan labelling on consumers*. Brussels: European Economic and Social Committee, 2016. https://op.europa.eu/en/publication-detail/-/publication/13cac894-fc83-11e5-b713-01aa75ed71a1 (accessed 2021-02-17).

Sivitos, Stamatis et al., Don’t just press the button!-Why appliance settings increasingly matter for efficiency delivery and rulemaking, in *ECEEE Summer Study Proceedings*, 2015.

Slade, Giles, *Made to Break: Technology and Obsolescence in America*, Cambridge, MA: Harvard University Press, 2007.

Stamminger, Rainer et al., Towards a durability test for washing-machines, *Resources, Conservation and Recycling*, vol. 131 (2018), 206–215.

Stone, Paul, How to Light: Do you know where you stand if an LED product fails early? *LuxReview*, 2015. https://www.luxreview.com/2015/04/17/promises-promises/ (accessed 2021-02-12).

Suikkanen, Johanna and Nissinen, Ari, *Circular Economy and the Nordic Swan Ecolabel: An Analysis of Circularity in the Product-Group-Specific Environmental Criteria*, TemaNord 2017:553. Copenhagen, Nordic Council of Ministers, 2017.

Swedish Chemicals Agency, *Regulatory mapping for remanufacturing of products under EU law*, PM 6/21. Stockholm, Swedish Chemicals Agency, 2021.

Svensson-Hoglund, Sahra et al. Barriers, enablers and market governance: A review of the policy landscape for repair of consumer electronics in the EU and the U.S., *Journal of Cleaner Production*, vol. 288 (2021), 125488.

Svensson-Höglund, Sahra et al., A Future of Fixing: Upscaled Repair Activities envisioned using a Circular Economy Repair Society System Framework, presented at *Electronics Goes Green 2020 Conference*, 2020.

Swaen, Valérie et al., *Labelling the durability of a product on its packaging: A pilot study*, 2014. https://www.eesc.europa.eu/en/news-media/presentations/labelling-durability-product-its-packaging-pilot-study (accessed 2021-02-17).

Swaen, Valérie et al., *Labelling the durability – the reparability of a product*, 2018. https://www.eesc.europa.eu/en/news-media/presentations/labelling-durability-reparability-product (accessed 2021-02-17).

Sønderskov, Kim M. and Daugbjerg, Carsten, The State and Consumer Confidence in Eco-Labeling: Organic Labeling in Denmark, Sweden, The United Kingdom and The United States. *Agriculture and Human Values*, vol. 28 (2011), 507–517.

Tang, Esther et al., Visual and Verbal Communication in the Design of Eco-Label for Green Consumer Products. *Journal of International Consumer Marketing*, vol. 16 (2004), 85–105.

Tasaki, Tomohiro et al., Assessing the replacement of electrical home appliances for the environment: An aid to consumer decision making. *Journal of Industrial Ecology*, vol. 17 (2013), 290–298.

Taylor, Margaret et al., Confronting regulatory cost and quality expectations: An exploration of technical change in minimum efficiency performance standards, *Resources for the Future*, 2015. https://www.rff.org/publications/working-papers/confronting-regulatory-cost-and-quality-expectations-an-exploration-of-technical-change-in-minimum-efficiency-performance-standards/ (accessed 2021-02-17).

Tecchio, Paolo et al., In search of standards to support circularity in product policies: A systematic approach, *Journal of Cleaner Production*, vol. 168 (2017) 1533–1546.

Tecchio, Paolo et al., Understanding lifetimes and failure modes of defective washing machines and dishwashers. *Journal of Cleaner Production*, vol. 215 (2019), 1112–1122.

Technopolis Group, *Regulatory barriers for the Circular Economy – Lessons from ten case studies*, Amsterdam: Technopolis group, 2016.

Teisl, Mario F. et al., Non-Dirty Dancing? Inter-actions between Eco-Labels and Consumers. *Journal of Economic Psychology*, vol. 29 (2008), 140–159.

Thøgersen, John, Promoting green consumer behavior with eco-labels, in T. Dietz & P. Stern (Eds.), *New tools for environmental protection: Education, information, and voluntary measures* (pp. 83–104). Washington, DC: National Academic Press, 2002.

Thøgersen, John, How may consumer policy empower consumers for sustainable lifestyles? *Journal of Consumer Policy*, vol. 28 (2005a), 143–178.

Thøgersen, John, Consumer behaviour and the environment: Which role for information? In S. Krarup & C. S. Russel (Eds.), *Environment, information and consumer behaviour* (pp. 51–63). Cheltenham: Edward Elgar, 2005b.

Tonner, Klaus and Malcolm, Rosalind, *How an EU lifespan guarantee model could be implemented across the European Union*, Directorate General for Internal Policies, Policy Department C: Citizens' Rights and Constitutional Affairs, Brussels: European Parliament, 2017.

Tuovila, Alicia, Depreciation, *Investopedia*, 2020. https://www.investopedia.com/terms/d/depreciation.asp (accessed 2021-02-17).

Tähkämö, Leena, *Life cycle assessment of light sources–Case studies and review of the analyses*, Diss., Helsinki: Aalto University, 2013.

UNEP (United Nations Environment Programme), *Guidelines for Providing Product Sustainability Information. Global guidance on making effective environmental, social and economic claims, to empower and enable consumer choice*, 2017. https://www.oneplanetnetwork.org/sites/default/files/guidelines_for_providing_product_sustainability_information_ci-scp_2017_revised.pdf (accessed 2021-02-17).

US International Trade Commission, *Remanufactured Goods: An Overview of the U.S. and Global Industries, Markets and Trade, Washington*, D.C.: U.S. International Trade Commission, 2012.

Van Buskirk, Robert et al, Refrigerator efficiency in Ghana: Tailoring an appliance market transformation program design for Africa. *Energy Policy*, vol. 35 (2007), 2401–2411.

Van Buskirk, Robert et al., A retrospective investigation of energy efficiency standards: policies may have accelerated long term declines in appliance costs. *Environmental Research Letters*, vol. 9 (2014), 114010.

Van Dam, Ynte K. and Reuvekamp, Mirjiam, Consumer knowledge and understanding of environmental seals in the Netherlands. In F. Hansen (Ed.), *European advances in consumer research* (Vol. 2, pp. 217–223). Provo: Association for Consumer Research, 1995.

van den Berge, Renske and Thysen, Tom, *State-of-the-art knowledge on user, market and legal issues related to premature obsolescence*. Premature Obsolescence Multi-Stakeholder Product Testing Program (PROMT) – Deliverable 2.6, 2020. https://prompt-project.eu/wp-content/uploads/2020/07/PROMPT_20200430_State-of-the-art-overview-of-the-user-market-and-legal-aspects.pdf (accessed 2021-02-17).

van Nes, Nicole and Cramer, Jaqueline, Influencing product lifetime through product design. *Business Strategy and the Environment*, vol. 14 (2005), 286–299.

VHK, *Ecodesign impacts accounting – Annual Report 2016*, Brussels: European Commission, 2016. https://ec.europa.eu/energy/sites/ener/files/documents/eia_ii_-_status_report_2016_rev20170314.pdf (accessed 2021-02-17).

VITO et al., *Lot 19: Domestic Lighting*, 2009. Study for European Commission DGTREN. https://www.eup-network.de/fileadmin/user_upload/4Working_Document_ENTR_Lot_4_CF_16May14_FINAL.pdf (accessed 2021-02-12).

VITO et al., *Preparatory Study on Ecodesign and Energy Labelling of rechargeable electrochemical batteries with internal storage*, 2019. https://ecodesignbatteries.eu/sites/ecodesignbatteries.eu/files/attachments/ED_Battery_Task%207_V45_final_corrected.pdf (accessed 2021-02-12).

Waechter, Signe et al., Desired and undesired effects of energy labels – An eyetracking study. *PLoS One*, vol. 10 (2015), 1–26.

Wagner, Swetlana and Schlummer, Martin, Legacy additives in a circular economy of plastics: Current dilemma, policy analysis, and emerging countermeasures, *Resources, Conservation and Recycling*, vol. 158 (2020), 104800.

Wang, Feng et al., Enhancing E-waste estimates: improving data quality by multivariate input–output analysis, *Waste Management*, 33 (2013), 2397–2407.

Ward, David O. et al., Factors Influencing Willingness-to-Pay for the ENERGY STAR® Label. *Energy Policy*, vol. 39 (2011), 1450–1458.

Wenker, Jan L. et al., A Methodical Approach for Systematic Life Cycle Assessment of Wood-Based Furniture. *Journal of Industrial Ecology*, vol. 22 (2018), 671–685.

Whittle, Colin et al., *The Effectiveness of Providing Pre-Purchase Factual Information in encouraging more Environmentally Sustainable Product Purchase Decisions: Expert Interviews and a Rapid Evidence Assessment*. WRAP UK, 2019.

Wieser Harald et al., The Consumers' Desired and Expected Product Lifetimes, in *Conference Product Lifetimes and the Environment 2015 Proceedings, 2015*. https://www.plateconference.org/consumers-desired-expected-product-lifetimes/ (accessed 2021-02-17).

Wieser, Harald and Tröger, Nina, Exploring the inner loops of the circular economy: Replacement, repair, and reuse of mobile phones in Austria. *Journal of Cleaner Production*, vol. 172 (2018), 3042–3055.

Wilson, Garrath T. et al., The hibernating mobile phone: Dead storage as a barrier to efficient electronic waste recovery. *Waste Management*, vol. 60 (2017), 521–533.

Wilts, Henning and O'Brien, Meghan, A Policy Mix for Resource Efficiency in the EU: Key Instruments, Challenges and Research Needs, *Ecological Economics*, vol. 155 (2019), 59–69.

WRAP, *Environmental life cycle assessment (LCA) study of replacement and refurbishment options for domestic washing machines*, WRAP UK, 2010.

WRAP, *Valuing our clothes: The cost of UK fashion*. WRAP UK, 2017.

Wrenn, Eddie, Apple 'Added Authentication Chip' to iPhone 5 Cable to Stop Third-Parties Making Cheaper Versions (then Charges you £30 for its Own Adapter), *Daily Mail Online*, 2012. https://www.dailymail.co.uk/sciencetech/article-2208298/iPhone-5-Apple-adds-authentication-chip-charger-cable-stop-parties-making-cheaper-versions.html (accessed 2021-02-17).

Wretlind, Per H., *Embodied Carbon in Buildings – Investigating drivers and barriers for the Swedish construction industry to address Embodied Carbon, and necessary policy support as deemed by the industry*, Diss., Lund: Lund University, 2015.

Your Europe, *Guarantees and returns*, 2020. https://europa.eu/youreurope/citizens/consumers/shopping/guarantees-returns/faq/index_en.htm (accessed 2021-02-17).

Åslund, Björn, Batterier från Biltema dör, men kan väckas igen, *Allt om elcyklar*, 2019. https://alltomelcyklar.nu/nyheter/batterier-fran-biltema-dor-men-kan-vackas-igen/ (accessed 2021-02-17).

Öhgren, Matilda, *Upphandling av rekonditionerade kontorsmöbler – En strategi för att stärka utvecklingen mot en cirkulärekonomi*, Diss., Lund: Lund University, 2017.

Öhgren, Matilda et al., Public procurement of remanufactured furniture and the potential for procuring product-service systems (PSS) solutions. *Procedia CIRP*, vol. 83 (2019), 151–156.

Annex I. Examples of EU product laws and regulations

Name	Abbreviation	Regulates	Area
Directive 2012/19 / EU on waste electrical and electronic equipment	WEEE Directive	The directive regulates the management of waste and covers collection and recycling targets.	Waste and recycling
Directive 2008/98 / EC Directive on waste and repeal of certain Directives	Framework Directive on waste	The directive stipulates the waste hierarchy that the member states must use in their waste management (definitions of waste, recycling, etc. can be found in the framework directive)	Waste and recycling
EC No 850/2004 Regulation on persistent organic pollutants	POPs Regulation	Regulates particularly dangerous chemicals, so-called. persistent organic pollutants such as decaBDE	Chemicals
EC No 1907/2006 Regulation on the Registration, Evaluation, Authorization and Restriction of Chemicals	REACH Regulation	Regulates on a general level the chemicals that are placed on the European market (incl. DecaBDE) through prohibitions, restrictions and licensing requirements.	Chemicals
2011/65 / EU Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment	RoHS Directive	The most comprehensive regulatory framework for limiting the presence of hazardous chemicals in e-products. DekaBDE is regulated in the directive.	Chemicals
Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products	Ecodesign Directive	Sets specific ecodesign requirements for various product groups. In some cases chemical content is regulate directly. In other cases, manufacturers must undertake communication efforts when there are dangerous substances in the products, e.g. to support recycling.	Energy, resources, water, chemicals, minimum requirements on functional performance
Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU	Energy Labelling Framework Regulation,	Mandates labelling of appliances in accordance with their energy efficiency performance, and to register products in a database. Sometimes, labelling includes other aspects than energy efficiency (e.g. noise levels, water consumption).	Energy

Name	Abbreviation	Regulates	Area
Directive 2009/48/EC of the European Parliament and of the Council of 18 June 2009 on the safety of toys	Toy Safety Directive	Restricts a number of substances – present in toys – by specific limit values, including CMR substances, heavy metals, and allergenic fragrances.	Safety, chemicals
Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits	Low voltage Directive (LVD)	The low voltage directive (LVD) (2014/35/EU) ensures that electrical equipment within certain voltage limits provides a high level of protection for European citizens.	It applies to a wide range of electrical equipment for both consumer and professional usage.

Annex II. Standards relevant for the circular economy: adopted or under development[339]

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
EN ISO 10210:2017 Plastics – Methods for the preparation of samples for biodegradation testing of plastic materials (ISO 10210:2012)	10210	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published
EN ISO 11469:2016 Plastics – Generic identification and marking of plastics products	11469	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
EN 13655:2018 Plastics – Thermoplastic mulch films recoverable after use, for use in agriculture and horticulture	13655	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
EN ISO 14851:2019 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium – Method by measuring the oxygen demand in a closed respirometer (ISO 14851:2019)	14851	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published
EN ISO 14852:2018 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium – Method by analysis of evolved carbon dioxide (ISO 14852:2018)	14852	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published
EN ISO 14853:2017 Plastics – Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system – Method by measurement of biogas production	14853	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published
EN 14995:2006 Plastics – Evaluation of compostability – Test scheme and specifications	14995	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
EN ISO 15270:2008 Plastics – Guidelines for the recovery and recycling of plastics waste	15270	Chemicals, Plastics & Rubber	Standards development	ISO	Completed or published
EN 15342:2007 Plastics – Recycled Plastics – Characterization of polystyrene (PS) recyclates	15342	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published

[339] The table is taken from: Delegationen för cirkulär ekonomi, *Slutrapport för Expertgruppen för cirkulära designprinciper*, 2020.

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
EN 15343:2007 Plastics – Recycled Plastics – Plastics recycling traceability and assessment of conformity and recycled content	15343	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
prEN 15344 Plastics – Recycled plastics – Characterisation of Polyethylene (PE) recyclates	15344	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
EN 15345:2007 Plastics – Recycled Plastics – Characterisation of Polypropylene (PP) recyclates	15345	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
EN 15346:2014 Plastics – Recycled plastics – Characterization of poly(vinyl chloride) (PVC) recyclates	15346	Chemicals, Plastics & Rubber	Standards development	CEN	Under revision
EN 15347:2007 Plastics – Recycled Plastics – Characterisation of plastics wastes	15347	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
EN 15348:2014 Plastics – Recycled plastics – Characterization of poly(ethyleneterephthalate) (PET) recyclates	15348	Chemicals, Plastics & Rubber	Standards development	CEN	Under revision
CEN TR 15351:2006 Plastics – Guide for vocabulary in the field of degradable and biodegradable polymers and plastic items	15351	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
CEN TR 15353:2007 Plastics – Recycled plastics – Guidelines for the development of standards relating for recycled plastics	15353	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
EN ISO 15985:2017 Plastics – Determination of the ultimate anaerobic biodegradation under highsolids anaerobic-digestion conditions – Method by analysis of released biogas (ISO 15985:2014)	15985	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published
CEN TS 16010:2013 Plastics – Recycled plastics – Sampling procedures for testing plastics waste and recyclates	16010	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
CEN TS 16011:2013 Plastics – Recycled plastics – Sample preparation	16011	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
CEN TS 16861:2015 Plastics – Recycled plastics – Determination of selected marker compounds in food grade recycled polyethylene terephthalate (PET)	16861	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
prEN ISO 16929 Plastics – Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test (ISO/DIS 16929:2018)	16929	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Working or drafting stage
EN 17033:2018 Plastics – Biodegradable mulch films for use in agriculture and horticulture – Requirements and test methods	17033	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
CEN TR 17219:2018 Plastics – Biodegradable thermoplastic mulch films for use in agriculture and horticulture – Guide for the quantification of alteration of films	17219	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
EN 17228:2019 Plastics – Bio-based polymers, plastics, and plastics products – Terminology, characteristics and communication	17228	Chemicals, Plastics & Rubber	Standards development	CEN	Completed or published
prEN 17410 Plastics – Controlled loop recycling of PVC-U profiles from windows and doors	17410	Chemicals, Plastics & Rubber	Standards development	CEN	Working or drafting stage
prEN 17417 Determination of the ultimate biodegradation of plastics materials in an aqueous system under anoxic (denitrifying) conditions – Method by measurement of pressure increase	17417	Chemicals, Plastics & Rubber	Standards development	CEN	Working or drafting stage
EN ISO 17422:2019 Plastics – Environmental aspects – General guidelines for their inclusion in standards (ISO 17422:2018)	17422	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published
EN ISO 17556:2019 Plastics – Determination of the ultimate aerobic biodegradability of plastic materials in soil by measuring the oxygen demand in a respirometer or the amount of carbon dioxide evolved (ISO 17556:2019)	17556	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
prEN 17615 Plastics – Environmental Aspects – Vocabulary (WI 00249A29)	17615	Chemicals, Plastics & Rubber	Standards development	CEN	Working or drafting stage
EN ISO 18830:2017 Plastics – Determination of aerobic biodegradation of non-floating plastic materials in a seawater/ sandy sediment interface – Method by measuring the oxygen demand in closed respirometer (ISO 18830:2016)	18830	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published
EN ISO 19679:2020 Plastics – Determination of aerobic biodegradation of non-floating plastic materials in a seawater/ sediment interface – Method by analysis of evolved carbon dioxide (ISO 19679:2016)	19679	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published
EN ISO 20200:2015 Plastics – Determination of the degree of disintegration of plastic materials under simulated composting conditions in a laboratory-scale test (ISO 20200:2015)	20200	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published
CEN ISO TR 21960:2020 Plastics in the environment – Current state of knowledge and methodologies	21960	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published
EN ISO 24187 Principles for the development of standards for investigation procedures of plastics in environmental media and materials (ISO/CD 24187:2020)	24187	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Working or drafting stage
Standardisation request M/563 as regards certain single-use plastic beverage containers with a capacity of up to three litres that have caps and lids made of plastic in support of Directive (EU) 2019/904		Chemicals, Plastics & Rubber	Standardization request & SRAHG	CEN	Completed or published
ISO/DIS 1043-4 rev Plastics – Symbols and abbreviated terms – Part 4: Flame retardants	1043-4	Chemicals, Plastics & Rubber	Standards development	ISO	Completed or published
EN ISO 14855-1:2012 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions – Method by analysis of evolved carbon dioxide – Part 1: General method (ISO 14855-1:2012)	14855-1	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
EN ISO 14855-2:2018 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions – Method by analysis of evolved carbon dioxide -Part 2: Gravimetric measurement of carbon dioxide evolved in a laboratory-scale test (ISO 14855-2:2018)	14855-2	Chemicals, Plastics & Rubber	Standards development	CEN-ISO (Vienna)	Completed or published
European Strategy for Plastics in a Circular Economy		Chemicals, Plastics & Rubber	Policy (leading to standards)	EC	Completed or published
Single Use Plastic Directive (EU) 2019/904		Chemicals, Plastics & Rubber	Policy (leading to standards)	EC	Completed or published
SRAHG Plastics Recycling and Recycled Plastics		Chemicals, Plastics & Rubber	Standardization request & SRAHG	CEN	Working or drafting stage
CEN prTS XXX Plastics – Recycled plastics – Determination of solid contaminants content (WI 00249A2B)		Chemicals, Plastics & Rubber	Standards development	CEN	Working or drafting stage
EN 12620 – Aggregates for concrete	12620	Construction	Standards development	CEN	Completed or published
EN 15804+A2:2019 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products	15804	Construction	Standards development	CEN	Completed or published
EN 15978 Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method	15978	Construction	Standards development	CEN	Under revision
European Environment Agency EEA Methodolgy and Analysis of decarbonization bene benefits of sectoral circular economy actions		Construction	Policy related research	EC	Completed or published
EN 15643-2: sustainbility of construction works	15643-2	Construction	Standards development	CEN	Completed or published
EN 197-1:2011 Cement – Part 1: Composition, specifications and conformity criteria for common cements	197-1	Construction	Standards development	CEN	Completed or published
EN 197-5 Cement – Part 5: Portland-composite cement CEM II/C-M and Composite cement CEM VI	197-5	Construction	Standards development	CEN	Working or drafting stage
EN 206 – Concrete – Specification, performance, production and conformity	206	Construction	Standards development	CEN	Completed or published

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
Standardisation request Gypsum and gypsum based products		Construction	Standardization request & SRAHG	EC	Working or drafting stage
Standardisation request Doors, windows, shutters, building hardware and curtain walling		Construction	Standardization request & SRAHG	EC	Working or drafting stage
Standardisation request Thermal insulating materials and products		Construction	Standardization request & SRAHG	EC	Working or drafting stage
Measuring circularity in the construction sector		Construction	Pre-standardization	National	Working or drafting stage
Framework for material pasports in construction		Construction	Pre-standardization	National	Working or drafting stage
Lexicon for circular construction		Construction	Pre-standardization	National	Completed or published
CEN189 WG5 Durability Annex – project group considering use of recycled materials in geosynthetics		Construction	Standards development	CEN	Working or drafting stage
CEN189 WG1 Review of mandate to include sustainability/circular economy etc. in geosynthetics		Construction	Standards development	CEN	Working or drafting stage
NTA 8190 Matrasetiket (Label for the content of matrasses)	8190	Consumer products	Standards development	National	Working or drafting stage
NTA 8195:2020 NL Circular textile – Requirements and categories	8195	Consumer products	Standards development	National	Completed or published
NTA XXXX Matraslabel (Label for the circularity of matrasses)		Consumer products	Standards development	National	Working or drafting stage
CEN Guide 16 'Guide for addressing chemicals in standards for consumer-relevant products'	16	Consumer products	Standards development	CEN	Completed or published
EU Report on critical raw materials and the circular economy		Defence & Security	Ancillary Action	EC	Completed or published
IEC 63110 Standardizing the Management of Electric Vehicle (Dis-)Charging Infrastructures	63110	Digital society	Standards development	IEC	Working or drafting stage
IEC 63119 Information exchange for Electric Vehicle charging roaming service	63119	Digital society	Standards development	IEC	Working or drafting stage
ISO 15118-20: Road vehicles – Vehicle to grid communication interface – Part 20: 2nd generation network and application protocol requirements	15118-20	Digital society	Standards development	Joint ISO-IEC	Working or drafting stage

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
EN 50491-12-2 Customer Energy Management (CEM) standard	50491-12-2	Digital society	Standards development	CENELEC	Working or drafting stage
IEC Guide 109 Environmental aspects – Inclusion in electrotechnical product standards	109	Electrotechnology	Other	Joint ISO-IEC	Proposal or preparatory
prEN 50614 Requirements for the preparing for re-use of waste electrical and electronic equipment	50614	Electrotechnology	Standards development	CENELEC	Working or drafting stage
EN TS 50625-series Collection, logistics & Treatment requirements for WEEE	50625	Electrotechnology	Standards development	CENELEC	Completed or published
EN 50672:2017 Ecodesign requirements for computers and computer servers	50672	Electrotechnology	Standards development	CENELEC	Completed or published
EN 50693:2019 Product category rules for life cycle assessments of electronic and electrical products and systems	50693	Electrotechnology	Standards development	CENELEC	Completed or published
IEC 62309:2004 Dependability of products containing reused parts – Requirements for functionality and tests	62309	Electrotechnology	Standards development	IEC	Completed or published
IEC EN 62321-x series Determination of certain substances in electrotechnical products	62321	Electrotechnology	Standards development	IEC	Completed or published
EN IEC 62474:2019/ prA1:2019 Material declaration for products of and for the electrotechnical industry	62474	Electrotechnology	Standards development	IEC	Completed or published
IEC TR 62476:2010 Guidance for evaluation of product with respect to substance-use restrictions in electrical and electronic products	62476	Electrotechnology	Standards development	IEC	Completed or published
IEC TR 62635:2012 Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment	62635	Electrotechnology	Standards development	IEC	Completed or published
EN 62717 LED modules for general lighting – Performance requirements	62717	Electrotechnology	Standards development	CENELEC	Completed or published
IEC TR 62824:2016 Guidance on material efficiency considerations in environmentally conscious design of electrical and electronic products	62824	Electrotechnology	Standards development	IEC	Completed or published

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
IEC/TR 62824 Guidance on material efficiency considerations in environmentally conscious design of electrical and electronic products	62824	Electrotechnology	Other	IEC	Completed or published
EN IEC 63000:2018/prA1:2020 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances – Amendment 1	63000	Electrotechnology	Standards development	IEC	Completed or published
IEC 63077:2020 Refurbishment of medical electrical equipment, medical electrical systems and sub-assemblies and reuse of components as part of the extended life-cycle	63077	Electrotechnology	Standards development	IEC	Working or drafting stage
EN IEC 63103 Lighting equipment. Non-active mode power measurement	63103	Electrotechnology	Standards development	IEC	Completed or published
IEC (FDIS) 63120:2019 Good refurbishment practices for medical imaging equipment	63120	Electrotechnology	Standards development	IEC	Completed or published
IEC TR 63212:2020 Harmonization of environmental performance criteria for electrical and electronic products – Feasibility study	63212	Electrotechnology	Standards development	IEC	Completed or published
IEC 63333 General method for assessing the proportion of reused components in products	63333	Electrotechnology	Standards development	IEC	Working or drafting stage
ETSI TR 103 476 Environmental Engineering (EE); Circular Economy (CE) in Information and Communication Technology (ICT); Definition of approaches, concepts and metrics	103476	Electrotechnology	Standards development	ETSI	Completed or published
EN 60598-1:2015 Luminaires – Part 1: General requirements and test	60598-1	Electrotechnology	Standards development	CENELEC	Completed or published
EN 62722-1:2016 Luminaire performance – Part 1: General requirements	62722-1	Electrotechnology	Standards development	CENELEC	Completed or published
EN-IEC 62722-2-1:2016 Luminaire performance – Part 2-1: Particular requirements for LED luminaires	62722-2-1	Electrotechnology	Standards development	IEC	Completed or published
IEC DTR 63XXX Guidance on material circularity considerations in environmentally conscious design	63xxx	Electrotechnology	Pre-standardization	IEC	Proposal or preparatory

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
WEEE Directive 2012/19/EU, as amended by Directive (EU) 2018/849		Electrotechnology	Policy (leading to standards)	EC	Completed or published
RoHS Directive 2011/65/EU, as amended by Directive (EU) 2017/2102		Electrotechnology	Policy (leading to standards)	EC	Completed or published
Revised regulatory framework for batteries		Electrotechnology	Policy (leading to standards)	EC	Working or drafting stage
SRAHG Batteries to support the upcoming regulatory framework for sustainable batteries		Electrotechnology	Standardization request & SRAHG	CENELEC	Working or drafting stage
PEP Ecopassport		Electrotechnology	Policy (leading to standards)	EC	Completed or published
IEC TC1/JWG2 Joint Working Group to undertake the development of an IEV part on terminology relating to the circular economy (in particular material efficiency)		Electrotechnology	Other	IEC	Proposal or preparatory
EN 16214:2012+A1:2019 Sustainability criteria for the production of biofuels and bioliquids for energy applications	16214	Energy & Utilities	Standards development	CEN	Completed or published
EN 50645:2017 Ecodesign requirements for small power transformersnorm	50645	Energy & Utilities	Standards development	CENELEC	Completed or published
EU Consultation Combined evaluation roadmap/inception Impact Assessment Directive + Roadmap 2018/2001		Energy & Utilities	Policy (leading to standards)	EC	Working or drafting stage
EU Communication from the Commission. A hydrogen strategy for a climate neutral Europe COM(2020) 301 final 8.7.2020		Energy & Utilities	Policy (leading to standards)	EC	Completed or published
EN 12502-1:2004 Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in water distribution and storage systems – Part 1: General	12502-1	Energy & Utilities	Standards development	CEN	Completed or published
Renewable Energy Directive 2018/2001/EU		Energy & Utilities	Policy (leading to standards)	EC	Completed or published
EU Consultation document Inception Impact Assessment Directive 2018/2001		Energy & Utilities	Policy (leading to standards)	EC	Working or drafting stage
FprTR 45550 Definitions related to material efficiency	45550	Energy-related Products	Standards development	Joint CEN-CLC	Completed or published

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
WITHDRAWN – TR 45551 Guidance on how to use generic material efficiency standards when writing energy related products specific standards	45551 WITHDRAWN	Energy-related Products	Other	Joint CEN-CLC	Proposal or preparatory
EN 45552:2020 General method for the assessment of the durability of energy-related products	45552	Energy-related Products	Standards development	Joint CEN-CLC	Completed or published
EN 45553:2020 General method for the assessment of the ability to remanufacture energy-related products	45553	Energy-related Products	Standards development	Joint CEN-CLC	Completed or published
EN 45554:2020 General methods for the assessment of the ability to repair, reuse and upgrade energy related products	45554	Energy-related Products	Standards development	Joint CEN-CLC	Completed or published
EN 45555:2019 General methods for assessing the recyclability and recoverability of energy-related products	45555	Energy-related Products	Standards development	Joint CEN-CLC	Completed or published
EN 45556:2019 General method for assessing the proportion of reused components in energy-related products	45556	Energy-related Products	Standards development	Joint CEN-CLC	Completed or published
EN 45557:2020 General method for assessing the proportion of recycled material content in energy-related products	45557	Energy-related Products	Standards development	Joint CEN-CLC	Completed or published
EN 45558:2019 General method to declare the use of critical raw materials in energy-related products	45558	Energy-related Products	Standards development	Joint CEN-CLC	Completed or published
EN 45559:2019 Methods for providing information relating to material efficiency aspects of energy-related products	45559	Energy-related Products	Standards development	Joint CEN-CLC	Completed or published
ZVEI Position Paper		Energy-related Products	Other	National	Completed or published
Sreq Sustainable fisheries, aquaculture and fishing gear		Food & Agriculture	Standardization request & SRAHG	EC	Working or drafting stage
Sustainable fisheries, aquaculture and fishing gear		Food & Agriculture	Standards development	CEN	Working or drafting stage
CEN TS 16765 LPG equipment and accessories – Environmental considerations for CEN/TC 286 standards	16765	Mechanical & Machines	Standards development	CEN	Completed or published

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
ISO 14955-1:2017 Machine tools – Environmental evaluation of machine tools – Part 1: Design methodology for energy-efficient machine tools	14955-1	Mechanical & Machines	Standards development	ISO	Completed or published
ISO 14955-2:2018 Machine tools – Environmental evaluation of machine tools – Part 2: Methods for measuring energy supplied to machine tools and machine tool components	14955-2	Mechanical & Machines	Standards development	ISO	Completed or published
ISO 14955-3:2020 Machine tools – Environmental evaluation of machine tools – Part 3: Principles for testing metal-cutting machine tools with respect to energy efficiency	14955-3	Mechanical & Machines	Standards development	ISO	
ISO 14955-4:2019 Machine tools – Environmental evaluation of machine tools – Part 4: Principles for measuring metal-forming machine tools and laser processing machine tools with respect to energy efficiency	14955-4	Mechanical & Machines	Standards development	ISO	
ISO 14955-5:2020 Machine tools – Environmental evaluation of machine tools – Part 5: Principles for testing woodworking machine tools with respect to energy supplied	14955-5	Mechanical & Machines	Standards development	ISO	
EN 643:2013 Paper and board – European list of standard grades of paper and board for recycling	643	Other materials	Standards development	CEN	
Ancillary action on Material efficient recycling and preparation for re-use		Other materials	Ancillary Action	EC	Working or drafting stage
ISO (FDIS) 14009:2020 Environmental management systems – Guidelines for incorporating material circulation in design and development	14009	Other/multiple/ horizontal	Standards development	ISO	Working or drafting stage
EN ISO 14025:2010 Environmental labels and declarations – Type III environmental declarations – Principles and procedures	14025	Other/multiple/ horizontal	Standards development	ISO	Completed or published
EN ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework	14040	Other/multiple/ horizontal	Standards development	ISO	Completed or published
EN ISO 14044:2006 LCA Requirements and Guidelines	14044	Other/multiple/ horizontal	Standards development	ISO	Completed or published

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
ISO TS 14048:2002 LCA data documentation format	14048	Other/multiple/horizontal	Standards development	ISO	Completed or published
ISO 20400:2017 Sustainable procurement – Guidance	20400	Other/multiple/horizontal	Standards development	ISO	Completed or published
ISO 26000:2010 Corporate social responsibility	26000	Other/multiple/horizontal	Standards development	ISO	Completed or published
ISO/WD 32210 Framework for sustainable finance: Principles and guidance.	32210	Other/multiple/horizontal	Standards development	ISO	Working or drafting stage
ISO/AWI 42500 Sharing Economy – Terminology and Principles	42500	Other/multiple/horizontal	Standards development	ISO	Proposal or preparatory
ISO WD 59004 Circular economy – Framework and principles for implementation	59004	Other/multiple/horizontal	Standards development	ISO	Working or drafting stage
ISO WD 59010 Circular economy – Guidelines on business models and value chains	59010	Other/multiple/horizontal	Standards development	ISO	Working or drafting stage
ISO WD 59020 Circular economy – Measuring circularity framework	59020	Other/multiple/horizontal	Standards development	ISO	Working or drafting stage
ISO CD TR 59031 Circular economy – Performance-based approach – Analysis of cases studies	59031	Other/multiple/horizontal	Standards development	ISO	Working or drafting stage
EN IEC 62430:2019 Environmentally conscious design (ECD) – Principles, requirements and guidance	62430	Other/multiple/horizontal	Standards development	Joint ISO-IEC	Completed or published
IWA 19:2017 Guidance principles for the sustainable management of secondary metals	19	Other/multiple/horizontal	Standards development	ISO	Completed or published
European Green Deal		Other/multiple/horizontal	Policy (leading to standards)	EC	Completed or published
New Circular Economy Action Plan		Other/multiple/horizontal	Policy (leading to standards)	EC	Completed or published
REGULATION (EU) 2020/852 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 June 2020		Other/multiple/horizontal	Policy (leading to standards)	EC	Completed or published
EU Communication A new Circular Economy action plan for cleaner and more competitive Europe		Other/multiple/horizontal	Policy (leading to standards)	EC	Completed or published
2050 long-term strategy		Other/multiple/horizontal	Policy (leading to standards)	EC	Completed or published
First European Climate Law		Other/multiple/horizontal	Policy (leading to standards)	EC	Proposal or preparatory

Name of the initiative	Standard nr	Applicable sector	Type of the initiative	Origin of the initiative	Stage of the initiative
Delegated Regulation (EU) 2019/807 on the determination of high indirect land-use change-risk feedstock for which a significant.ex.pansion of the production area into land with high carbon stock is observed and the certification of low indirect land-use change-risk biofuels, bioliquids and biomass fuels		Other/ multiple/ horizontal	Policy (leading to standards)	EC	Completed or published
Waste Framework Directive 2008/98/EC, as amdned by Directive 2008/98/EC		Other/multiple/ horizontal	Policy (leading to standards)	EC	Completed or published
ECHA SCIP Database		Other/multiple/ horizontal	Other	EC	Working or drafting stage
XP X30-901 – Circular economy – Circular economy project management system – Requirements and guidelines		Other/multiple/ horizontal	Standards development	National	Completed or published
EN ISO 14021 – Environmental labels and declarations – Self declared environmental claims (Type II environmental labelling)	14021	Other/multiple/ horizontal	Standards development	CEN-ISO (Vienna)	Completed or published
EN 13430:2000 Packaging – Requirements for packaging recoverable by material recycling	13430	Transport, Vehicles & Packaging	Standards development	CEN	Completed or published
EN 13430:2004 Packaging – Requirements for packaging recoverable by material recycling	13430	Transport, Vehicles & Packaging	Standards development	CEN	Completed or published
EN 13437:2003 Packaging and material recycling – Criteria for recycling methods – Description of recycling processes and flow chart	13437	Transport, Vehicles & Packaging	Standards development	CEN	Completed or published
EN 13440:2003 Packaging – Rate of recycling – Definition and method of calculation	13440	Transport, Vehicles & Packaging	Standards development	CEN	Completed or published
CEN TR 13688:2008 Packaging – Material recycling – Report on requirements for substances and materials to prevent a sustained impediment to recycling	13688	Transport, Vehicles & Packaging	Standards development	CEN	Completed or published
prEN Quality grades for plastic packaging for recycling and measuring recycling		Transport, Vehicles & Packaging	Standards development	CEN	Proposal or preparatory

Annex III. Examples of need for new standardization activities, for different sectors.[340]

Description of the needed initiative	Applicable sector of need	Type of need	Key objective of the needed initiative
Digital Twin – properties	Construction	Research	ME – Lifetime extention strategies
Tracking of structral elements in digital twin	Construction	Research	ME – Lifetime extention strategies
Definition of non-destructive material tests	Construction	Research	ME – Lifetime extention strategies
Material quality assessment	Other/multiple/ horizontal	Standardization	ME – Recycling/ End-of-life
Characterization of hazardous components and functional quality requirements of secondary raw materials	Other materials	Standardization	ME – Recycling/ End-of-life
Standardized monitoring the quality of waste streams in several specific phases of the chain	Other materials	Standardization	ME – Recycling/ End-of-life
Standardistation request on circularity of construction products	Construction	Standardization	ME – Recycling/ End-of-life
Communication of chemical content	Chemicals, Plastics & Rubber	Standardization	ME – Recycling/ End-of-life
Reusable packaging formats	Transport, Vehicles & Packaging	Standardization	ME – Lifetime extention strategies
Product-specific standards that facilitate reuse, repair, remanufacturing and recycling	Consumer products	Standardization	ME – Lifetime extention strategies
End-of-waste criteria for Waste Derived Fuels, including from Solid Recovered Fuels and chemical recycling processes	Other/multiple/ horizontal	Policy	ME – Recycling/ End-of-life
Microplastics	Chemicals, Plastics & Rubber	Standardization	Circular impact
Standardisation request for test methods for the measurement of tyre abrasion and mileage (durability)	Chemicals, Plastics & Rubber	Standardization	Circular impact
Standardisation request to measure the fibre wear-off during washing cycles	Consumer products	Standardization	Circular impact
Harmonised set of best practices to minimise pellet loss throughout the supply chain	Other/ multiple/ horizontal	Policy	Circular impact

[340] Taken from Delegationen för cirkulär ekonomi, *Slutrapport för Expertgruppen för cirkulära designprinciper*, 2020.

Description of the needed initiative	Applicable sector of need	Type of need	Key objective of the needed initiative
Standards supporting textile reuse and high-quality textile-to-textile recycling	Consumer products	Standardization	Circular impact
EU Implementing Act laying down minimum quality standards for the treatment, collection, logistics and preparation for re-use of WEEE	Electrotechnology	Regulatory	ME – Recycling/ End-of-life
Standardisation request on quality standards for secondary Critical Raw Materials (CRMs)	Electrotechnology	Standardization	ME – Recycling/ End-of-life
Standardisation request for servers and data storage products	Electrotechnology	Standardization	ME – Lifetime extention strategies
Standardisation request on performance and durability of recharging batteries	Energy & Utilities	Policy	ME – Lifetime extention strategies
Standardisation request on requirements that facilitate the repair, repurposing and reuse of batteries	Energy & Utilities	Policy	ME – Recycling/ End-of-life
Standardistation request on smart charging standards	Digital society	Policy	Renewables/ Food chain
Standardisation request on energy performance and material requirements for electric kettles	Household appliances & HVAC	Standardization	ME – Lifetime extention strategies
Standardisation request for Building Automation Control Systems (BACS)	Household appliances & HVAC	Standardization	ME – Lifetime extention strategies
Standardisation request for vacuum cleaners	Household appliances & HVAC	Standardization	ME – Lifetime extention strategies
Standardisation request for tumble dryers	Household appliances & HVAC	Standardization	ME – Lifetime extention strategies
Standardisation request for photovoltaic panels (PV)	Household appliances & HVAC	Standardization	ME – Lifetime extention strategies
Standardisation request for computers	Household appliances & HVAC	Standardization	ME – Lifetime extention strategies
Standardisation request for household cooking appliances	Household appliances & HVAC	Standardization	ME – Lifetime extention strategies
Standardisation request for non-household washing machines and dishwashers	Mechanical & Machines	Standardization	ME – Lifetime extention strategies
Standardisation requests for improved and adapted verification procedures for large and complex products such as power transformers	Mechanical & Machines	Standardization	Circular impact
Standardisation of waste qualities for input to recycling process	Chemicals, Plastics & Rubber	Standardization	ME – Recycling/ End-of-life
Standardisation of minimum recyclate qualities for defined applications	Chemicals, Plastics & Rubber	Standardization	ME – Recycling/ End-of-life

Description of the needed initiative	**Applicable sector of need**	**Type of need**	**Key objective of the needed initiative**
Standardisation of measurement systems for microplastics in the environment	Chemicals, Plastics & Rubber	Standardization	Circular impact
Standardisation of entry paths of plastics into the environment	Chemicals, Plastics & Rubber	Standardization	Circular impact
Standardisation of recycled content for products from chemical recycling	Chemicals, Plastics & Rubber	Standardization	ME – Recycling/ End-of-life
Revision of standards with limitations to use of recycled materials	Chemicals, Plastics & Rubber	Standardization	Circular impact
Guidance on biodegradable and compostable plastics	Chemicals, Plastics & Rubber	Standardization	Circular impact
Review of standards for definition and labelling of compostable and biodegradable plastics	Chemicals, Plastics & Rubber	Standardization	Terminology/ Communication
Standards for sorting processes	Chemicals, Plastics & Rubber	Standardization	ME – Recycling/ End-of-life
Standards for harmonized collection systems	Chemicals, Plastics & Rubber	Standardization	ME – Recycling/ End-of-life
Assessment of the the environmental impact of the construction work site as whole	Construction	Regulatory	ME – Recycling/ End-of-life
Circular Ready Design	Energy-related Products	Standardization	ME – Lifetime extention strategies
Terms and definition of recycling, recycled content	Construction	Regulatory	Terminology / Communication
Identification of the product (product passports)			ME – Recycling/ End-of-life
Design for recycling			ME – Recycling/ End-of-life

Annex IV. Examples of requirements related to durability and repairability in new Ecodesign Regulations

<table>
<tr><th>Ecodesign Regulation</th><th>Main rules/criteria</th></tr>
<tr><td>Commission Regulation (EU) 2019/2019 on refrigerators</td><td>Resource efficiency requirements:
From 1 March 2021, refrigerating appliances shall meet the following requirements:
(a) Availability of spare parts:
(1) manufacturers, importers or authorised representatives of refrigerating appliances shall make available to professional repairers at least the following spare parts: thermostats, temperature sensors, printed circuit boards and light sources, for a minimum period of seven years after placing the last unit of the model on the market;
(2) manufacturers, importers or authorised representatives of refrigerating appliances shall make available to professional repairers and end-users at least the following spare parts: door handles, door hinges, trays and baskets for a minimum period of seven years and door gaskets for a minimum period of 10 year, after placing the last unit of the model on the market;
(3) manufacturers shall ensure that these spare parts can be replaced with the use of commonly available tools and without permanent damage to the appliance;
(4) the list of spare parts concerned by point (1) and the procedure for ordering them shall be publicly available on the free access website of the manufacturer, importer or authorised representative, at the latest two years after the placing on the market of the first unit of a model and until the end of the period of availability of these spare parts;
(5) the list of spare parts concerned by point (2) and the procedure for ordering them and the repair instructions shall be publicly available on the manufacturer's, the importer's or authorised representative's free access website, at the moment of the placing on the market of the first unit of a model and until the end of the period of availability of these spare parts.
(b) Access to repair and maintenance information:
After a period of two years after the placing on the market of the first unit of a model or of an equivalent model, and until the end of the period mentioned under (a), the manufacturer, importer or authorised representative shall provide access to the appliance repair and maintenance information to professional repairers in the following conditions:
(1) the manufacturer's, importer's or authorised representative's website shall indicate the process for professional repairers to register for access to information; to accept such a request, manufacturers, importers or authorised representative may require the professional repairer to demonstrate that:
(i) the professional repairer has the technical competence to repair refrigerating appliances and complies with the applicable regulations for repairers of electrical equipment in the Member States where it operates. Reference to an official registration system as professional repairer, where such system exists in the Member States concerned, shall be accepted as proof of compliance with this point;
(ii) the professional repairer is covered by insurance covering liabilities resulting from its activity, regardless of whether this is required by the Member State;</td></tr>
</table>

Ecodesign Regulation	Main rules/criteria
	(2) the manufacturers, importers or authorised representatives shall accept or refuse the registration within 5 working days from the date of request by the professional repairer; (3) manufacturers, importers or authorised representatives may charge reasonable and proportionate fees for access to the repair and maintenance information or for receiving regular updates. A fee is reasonable if it does not discourage access by failing to take into account the extent to which the professional repairer uses the information; Once registered, a professional repairer shall have access, within one working day after requesting it, to the requested repair and maintenance information. The available repair and maintenance information shall include: • the unequivocal appliance identification; • a disassembly map or exploded view; • a list of necessary repair and test equipment; • component and diagnosis information (such as minimum and maximum theoretical values for measurements); • wiring and connection diagrams; • diagnostic fault and error codes (including manufacturer-specific codes, where applicable); and data records of reported failure incidents stored on the refrigerating appliance (where applicable). (c) Maximum delivery time of spare parts: (1) during the period mentioned under point 3(a)(1) and point 3(a)(2), the manufacturer, importer or authorised representatives shall ensure the delivery of the spare parts for refrigerating appliances within 15 working days after having received the order; (2) in the case of spare parts available only to professional repairers this availability may be limited to professional repairers registered in accordance with point b. (d) Requirements for dismantling for material recovery and recycling while avoiding pollution: (1) manufacturers, importers or authorised representatives shall ensure that refrigerating appliances are designed in such a way that the materials and components referred to in Annex VII to Directive 2012/19/EU can be removed with the use of commonly available tools; (2) manufacturers, importers and authorised representatives shall fulfil the obligations laid down in Point 1 of Article 15 of Directive 2012/19/EU. **4. Information requirements:** From 1 March 2021, instruction manuals for installers and end-users, and free access website of manufacturers, importers or authorised representatives shall include the following information: (j) access to professional repair, such as internet webpages, addresses, contact details; (k) relevant information for ordering spare parts, directly or through other channels provided by the manufacturer, importer or authorised representative; (l) the minimum period during which spare parts, necessary for the repair of the appliance, are available; (m) the minimum duration of the guarantee of the refrigerating appliance offered by the manufacturer, importer or authorised representative;

Ecodesign Regulation	Main rules/criteria
Commission Regulation (EU) 2019/2021: Electronic displays	**D. MATERIAL EFFICIENCY REQUIREMENTS** From 1 March 2021, electronic displays shall meet the requirements indicated below. **1. Design for dismantling, recycling and recovery** Manufacturers, importers or their authorised representatives shall ensure that joining, fastening or sealing techniques do not prevent the removal, using commonly available tools, of the components indicated in point 1 of Annex VII of Directive 2012/19/EU on WEEE or in Article 11 of Directive 2006/66/EC of the European Parliament and of the Council (1) on batteries and accumulators and waste batteries and accumulators, when present. Manufacturers, importers or their authorised representatives shall, without prejudice to point 1 of Article 15 of Directive 2012/19/EU, make available, on a free-access website, the dismantling information needed to access any of the products components referred to in point 1 of Annex VII of Directive 2012/19/EU. This dismantling information shall include the sequence of dismantling steps, tools or technologies needed to access the targeted components. The end of life information shall be available until at least 15 years after the placing on the market of the last unit of a product model. **5. Design for repair and reuse** (a) Availability of spare parts: (1) manufacturers, importers or authorised representatives of electronic displays shall make available to professional repairers at least the following spare parts: internal power supply, connectors to connect external equipment (cable, antenna, USB, DVD and Blue-Ray), capacitors, batteries and accumulators, DVD/Blue-Ray module if applicable and HD/SSD module if applicable for a minimum period of seven years after placing the last unit of the model on the market; (2) manufacturers, importers or authorised representatives of electronic displays shall make available to professional repairers and end-users at least the following spare parts: external power supply and remote control for a minimum period of seven years after placing the last unit of the model on the market; (3) manufacturers shall ensure that these spare parts can be replaced with the use of commonly available tools and without permanent damage to the appliance; (4) the list of spare parts concerned by point 1 and the procedure for ordering them shall be publicly available on the free access website of the manufacturer, importer or authorised representative, at the latest two years after the placing on the market of the first unit of a model and until the end of the period of availability of these spare parts; and (5) the list of spare parts concerned by point 2 and the procedure for ordering them and the repair instructions shall be publicly available on the manufacturer's, the importer's or authorised representative's free access website, at the moment of the placing on the market of the first unit of a model and until the end of the period of availability of these spare parts.

Ecodesign Regulation	Main rules/criteria
	(b) Access to repair and maintenance information After a period of two years after the placing on the market of the first unit of a model or of an equivalent model, and until the end of the period mentioned under (a), the manufacturer, importer or authorised representative shall provide access to the appliance repair and maintenance information to professional repairers in the following conditions: (1) the manufacturer's, importer's or authorised representative's website shall indicate the process for professional repairers to register for access to information; to accept such a request, manufacturers, importers or authorised representative may require the professional repairer to demonstrate that: (i) the professional repairer has the technical competence to repair electronic displays and complies with the applicable regulations for repairers of electrical equipment in the Member States where it operates. Reference to an official registration system as professional repairer, where such system exists in the Member States concerned, shall be accepted as proof of compliance with this point; (ii) the professional repairer is covered by insurance covering liabilities resulting from its activity, regardless of whether this is required by the Member State; (2) the manufacturers, importers or authorised representatives shall accept or refuse the registration within 5 working days from the date of request by the professional repairer; (3) manufacturers, importers or authorised representatives may charge reasonable and proportionate fees for access to the repair and maintenance information or for receiving regular updates. A fee is reasonable if it does not discourage access by failing to take into account the extent to which the professional repairer uses the information. Once registered, a professional repairer shall have access to the requested repair and maintenance information within one working day after requesting it. The available repair and maintenance information shall include: • the unequivocal appliance identification; • a disassembly map or exploded view; • list of necessary repair and test equipment; • component and diagnosis information (such as minimum and maximum theoretical values for measurements); • wiring and connection diagrams; • diagnostic fault and error codes (including manufacturer-specific codes, where applicable); and • data records of reported failure incidents stored on the electronic display (where applicable). (c) Maximum delivery time of spare parts (1) during the period mentioned under point 5(a)(1) and point 5(a)(2), the manufacturer, importer or authorised representatives shall ensure the delivery of the spare parts for electronic displays within 15 working days after having received the order; (2) in the case of spare parts available only to professional repairers, this availability may be limited to professional repairers registered in accordance with point (b).

Ecodesign Regulation	Main rules/criteria
	E. INFORMATION AVAILABILITY REQUIREMENTS From 1 March 2021, the product manufacturer, importer or authorised representative shall make available the information set out below when placing on the market the first unit of a model or of an equivalent model. The information shall be provided free of charge to third parties dealing with professional repair and reuse of electronic displays (including third party maintenance actors, brokers and spare parts providers). **1. Availability of software and firmware updates** (a) The latest available version of the firmware shall be made available for a minimum period of eight years after the placing on the market of the last unit of a certain product model, free of charge or at a fair, transparent and non-discriminatory cost. The latest available security update to the firmware shall be made available until at least eight years after the placing on the market of the last product of a certain product model, free of charge. (b) Information on the minimum guaranteed availability of software and firmware updates, availability of spare parts and product support shall be indicated in the product information sheet as from Annex V of Regulation (EU) 2019/2013.
Commission Regulation (EU) 2019/2023 Washing machines	**4. FUNCTIONAL REQUIREMENTS** From 1 March 2021, household washing machines and household washer-dryers shall meet the following requirements: (1) for household washing machines with a rated capacity higher than 3 kg and for the washing cycle of household washer-dryers with a rated capacity higher than 3 kg, the Washing Efficiency Index (I_w) of the eco 40–60 programme shall be greater than 1,03 for each of the following loading sizes: rated washing capacity, half of the rated washing capacity and a quarter of the rated washing capacity; (2) for household washing machines with a rated capacity lower than or equal to 3 kg and for the washing cycle of household washer-dryers with a rated capacity lower than or equal to 3 kg, the Washing Efficiency Index (I_w) of the eco 40–60 programme shall be greater than 1,00 at rated washing capacity; (3) for household washer-dryers with a rated capacity higher than 3 kg, the Washing Efficiency Index (J_w) of the wash and dry cycle shall be greater than 1,03 at rated capacity and at half of the rated capacity; (4) for household washer-dryers with a rated capacity lower than or equal to 3 kg, the Washing Efficiency Index (J_w) of the wash and dry cycle shall be greater than 1,00 at rated capacity; (5) for household washing machines with a rated capacity higher than 3 kg and for the washing cycle of household washer-dryers with a rated capacity higher than 3 kg, the Rinsing Effectiveness (I_R) of the eco 40–60 programme shall be smaller than or equal to 5,0 g/kg for each of the following loading sizes: rated washing capacity, half of the rated washing capacity and a quarter of the rated washing capacity; (6) for household washer-dryers with a rated capacity higher than 3 kg, the Rinsing Effectiveness (J_R) of the wash and dry cycle shall be smaller than or equal to 5,0 g/kg at rated capacity and at half of the rated capacity. The I_w, J_w, I_R and J_R shall be calculated in accordance with Annex III.

Ecodesign Regulation	Main rules/criteria
	5. REQUIREMENTS ON DURATION From 1 March 2021, household washing machines and household washer-dryers shall meet the following requirements: the duration of the eco 40–60 programme (t_W), expressed in hours and minutes and rounded to the nearest minute, shall be lower than or equal to the time limit t_{cap}, which depends on the rated capacity as follows: (1) for the rated washing capacity, the time limit is given by the following equation: t_{cap}(in min) =137 + c × 10,2 with a maximum of 240 minutes; (2) for half of the rated washing capacity and a quarter of the rated washing capacity, the time limit is given by the following equation: t_{cap}(in min) =120 + c × 6 with a maximum of 180 minutes; where c is the rated capacity of the household washing machine or the rated washing capacity of the household washer-dryer for the eco 40–60 programme. **8. RESOURCE EFFICIENCY REQUIREMENTS** From 1 March 2021, household washing machines and household washer-dryers shall meet the following requirements: (1) availability of spare parts: (a) manufacturers, importers or authorised representatives of household washing machines and household washer-dryers shall make available to professional repairers at least the following spare parts, for a minimum period of 10 years after placing the last unit of the model on the market: • motor and motor brushes; • transmission between motor and drum; • pumps; • shock absorbers and springs; • washing drum, drum spider and related ball bearings (separately or bundled); • heaters and heating elements, including heat pumps (separately or bundled); • piping and related equipment including all hoses, valves, filters and aquastops (separately or bundled); • printed circuit boards; • electronic displays; • pressure switches; • thermostats and sensors; • software and firmware including reset software; (b) manufacturers, importers or authorised representatives of household washing machines and household washer-dryers shall make available to professional repairers and end-users at least the following spare parts: door, door hinge and seals, other seals, door locking assembly and plastic peripherals such as detergent dispensers, for a minimum period of 10 years after placing the last unit of the model on the market; (c) manufacturers, importers or authorised representatives of household washing machines and household washer-dryers shall ensure that the spare parts mentioned in points (a) and (b) can be replaced with the use of commonly available tools and without permanent damage to the household washing machine or household washer-dryer;

Ecodesign Regulation	Main rules/criteria
	(d) the list of spare parts concerned by point (a) and the procedure for ordering them shall be publicly available on the free access website of the manufacturer, importer or authorised representative, at the latest two years after the placing on the market of the first unit of a model and until the end of the period of availability of these spare parts; (e) the list of spare parts concerned by point (b) and the procedure for ordering them and the repair instructions shall be publicly available on the free access website of the manufacturer, importer or authorised representative, when placing the first unit of a model on the market and until the end of the period of availability of these spare parts; (2) maximum delivery time of spare parts: (a) during the period mentioned under (1), the manufacturer, importer or authorised representative shall ensure the delivery of the spare parts within 15 working days after having received the order; (b) in the case of spare parts concerned by point (1)(a), the availability of spare parts may be limited to professional repairers registered in accordance with point (3)(a) and (b); (3) access to Repair and Maintenance Information: after a period of two years after the placing on the market of the first unit of a model and until the end of the period mentioned under (1), the manufacturer, importer or authorised representative shall provide access to the household washing machine or household washer-dryer repair and maintenance information to professional repairers in the following conditions: (a) the manufacturer's, importer's or authorised representative's website shall indicate the process for professional repairers to register for access to information; to accept such a request, the manufacturers, importers or authorised representatives may require the professional repairer to demonstrate that: (i) the professional repairer has the technical competence to repair household washing machines and household washer-dryers and complies with the applicable regulations for repairers of electrical equipment in the Member States where it operates. Reference to an official registration system as professional repairer, where such system exists in the Member States concerned, shall be accepted as proof of compliance with this point; (ii) the professional repairer is covered by insurance covering liabilities resulting from its activity regardless of whether this is required by the Member State; (b) manufacturers, importers or authorised representatives shall accept or refuse the registration within 5 working days from the date of request; (c) manufacturers, importers or authorised representatives may charge reasonable and proportionate fees for access to the repair and maintenance information or for receiving regular updates. A fee is reasonable if it does not discourage access by failing to take into account the extent to which the professional repairer uses the information; (d) once registered, a professional repairer shall have access, within one working day after requesting it, to the requested repair and maintenance information. The information may be provided for an equivalent model or model of the same family, if relevant;

Ecodesign Regulation	Main rules/criteria
	(e) the household washing machine or household washer-dryer repair and maintenance information referred to in (a) shall include: • the unequivocal household washing machine or household washer-dryer identification; • a disassembly map or exploded view; • technical manual of instructions for repair; list of necessary repair and test equipment; • component and diagnosis information (such as minimum and maximum theoretical values for measurements); • wiring and connection diagrams; • diagnostic fault and error codes (including manufacturer-specific codes, where applicable); • instructions for installation of relevant software and firmware including reset software; and • information on how to access data records of reported failure incidents stored on the household washing machine or washer-dryer (where applicable); (4) information requirements for refrigerant gases: without prejudice to Regulation (EU) No 517/2014 of the European Parliament and of the Council[341], for household washing machines and household washer-dryers equipped with a heat pump, the chemical name of the refrigerant gas used, or equivalent reference such as a commonly used and understood symbol, label or logo, shall be displayed permanently and in a visible and readable way on the exterior of the household washing machines or household washer-dryers, for example on the back panel. More than one reference can be used for the same chemical name; (5) requirements for dismantling for material recovery and recycling while avoiding pollution: • manufacturers, importers or authorised representatives shall ensure that household washing machines and household washer-dryers are designed in such a way that the materials and components referred to in Annex VII to Directive 2012/19/EU can be removed with the use of commonly available tools; • manufacturers, importers or authorised representatives shall fulfil the obligations laid down in point 1 of Article 15 of Directive 2012/19/EU.
Commission Regulation (EU) 2019/2022 (Dishwashers)	**5. RESOURCE EFFICIENCY REQUIREMENTS** From 1 March 2021, household dishwashers shall meet the following requirements: (1) availability of spare parts: (a) the manufacturers, importers or authorised representatives of household dishwashers shall make available to professional repairers at least the following spare parts, for a minimum period of seven years after placing the last unit of the model on the market: • motor; • circulation and drain pump; • heaters and heating elements, including heat pumps (separately or bundled); • piping and related equipment including all hoses, valves, filters and aquastops; • structural and interior parts related to door assemblies (separately or bundled); • printed circuit boards; • electronic displays; • pressure switches; • thermostats and sensors; • software and firmware including reset software;

[341] Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006 (OJ L 150, 20.5.2014, p. 195).

Ecodesign Regulation	Main rules/criteria
	(b) the manufacturers, importers or authorised representatives of household dishwashers shall make available to professional repairers and end-users at least the following spare parts: door hinge and seals, other seals, spray arms, drain filters, interior racks and plastic peripherals such as baskets and lids, for a minimum period of 10 years after placing the last unit of the model on the market; (c) the manufacturers, importers or authorised representatives of household dishwashers shall ensure that the spare parts mentioned in points (a) and (b) can be replaced with the use of commonly available tools and without permanent damage to the appliance; (d) the list of spare parts concerned by point (a) and the procedure for ordering them shall be publicly available on the free access website of the manufacturer, importer or authorised representative, at the latest two years after the placing on the market of the first unit of a model and until the end of the period of availability of these spare parts; (e) the list of spare parts concerned by point (b) and the procedure for ordering them and the repair instructions shall be publicly available on the free access website of the manufacturer, importer or authorised representative, when placing the first unit of a model on the market and until the end of the period of availability of these spare parts; (2) maximum delivery time of spare parts: (a) during the period mentioned under point (1), the manufacturer, importer or authorised representative shall ensure the delivery of the spare parts within 15 working days after having received the order; (b) in the case of spare parts concerned by point (1)(a), the availability of spare parts may be limited to professional repairers registered in accordance with point (3)(a) and (b); (3) access to Repair and Maintenance Information: after a period of two years after the placing on the market of the first unit of a model, and until the end of the period mentioned under (1), the manufacturer, importer or authorised representative shall provide access to the appliance repair and maintenance information to professional repairers in the following conditions: (a) the manufacturer's, importer's or authorised representative's website shall indicate the process for professional repairers to register for access to information; to accept such a request, the manufacturers, importers or authorised representatives may require the professional repairer to demonstrate that: (i) the professional repairer has the technical competence to repair household dishwashers and complies with the applicable regulations for repairers of electrical equipment in the Member States where it operates. Reference to an official registration system as professional repairer, where such system exists in the Member States concerned, shall be accepted as proof of compliance with this point; (ii) the professional repairer is covered by insurance covering liabilities resulting from its activity regardless of whether this is required by the Member State; (b) the manufacturers, importers or authorised representatives shall accept or refuse the registration within 5 working days from the date of the request;

Ecodesign Regulation	Main rules/criteria
	(c) the manufacturers, importers or authorised representatives may charge reasonable and proportionate fees for access to the repair and maintenance information or for receiving regular updates. A fee is reasonable if it does not discourage access by failing to take into account the extent to which the professional repairer uses the information; once registered, a professional repairer shall have access, within one working day after requesting it, to the requested repair and maintenance information. The information may be provided for an equivalent model or model of the same family, if relevant; the available repair and maintenance information shall include: • the unequivocal appliance identification; • a disassembly map or exploded view; • list of necessary repair and test equipment; • component and diagnosis information (such as minimum and maximum theoretical values for measurements); • wiring and connection diagrams; • diagnostic fault and error codes (including manufacturer-specific codes, where applicable); • instructions for installation of relevant software and firmware including reset software; and • information on how to access data records of reported failure incidents stored on the household dishwasher (where applicable); (4) information requirements for refrigerant gases: without prejudice to Regulation (EU) No 517/2014 of the European Parliament and of the Council[342], for household dishwashers equipped with a heat pump, the chemical name of the refrigerant gas used, or equivalent reference such as a commonly used and understood symbol, label or logo, shall be displayed permanently and in a visible and readable way on the exterior of the appliance, for example on the back panel. More than one reference can be used for the same chemical name; (5) requirements for dismantling for material recovery and recycling while avoiding pollution: • manufacturers, importers or authorised representatives shall ensure that household dishwashers are designed in such a way that the materials and components referred to in Annex VII to Directive 2012/19/EU can be removed with the use of commonly available tools, • manufacturers, importers or authorised representatives shall fulfil the obligations laid down in Article 15, Point 1 of Directive 2012/19/EU. **INFORMATION REQUIREMENTS** (13) identification of errors, the meaning of the errors, and the action required, including identification of errors requiring professional assistance; (14) how to access professional repair (internet webpages, addresses, contact details). Such instructions shall also include information on: (15) any implications of self-repair or non-professional repair for the safety of the end-user and for the guarantee; (16) the minimum period during which spare parts for the household dishwasher are available.

[342] Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006 (OJ L 150, 20.5.2014, p. 195).

Ecodesign Regulation	Main rules/criteria
Commission Regulation (EU) 2019/2024 (refrigerating appliances with a direct sales function)	**Resource efficiency requirements:** From 1 March 2021, refrigerating appliances with a direct sales function shall meet the following requirements: (a) Availability of spare parts (1) Manufacturers, importers or authorised representatives of refrigerating appliances with a direct sales function shall make available to professional repairers at least the following spare parts: • thermostats; • starting relays; • no-frost heating resistors; • temperature sensors; • software and firmware including reset software; • printed circuit boards; and • light sources; for a minimum period of eight years after placing the last unit of the model on the market. (2) Manufacturers, importers or authorised representatives of refrigerating appliances with a direct sales function shall make available to professional repairers and end-users at least the following spare parts: • door handles and door hinges; • knobs, dials and buttons; • door gaskets; and • peripheral trays, baskets and racks for storage; for a minimum period of eight years after placing the last unit of the model on the market. (3) Manufacturers, importers or authorised representatives of refrigerating appliances with a direct sales function shall ensure that the spare parts mentioned in points (1) and (2) can be replaced with the use of commonly available tools and without permanent damage to the appliance. (4) The list of spare parts concerned by point (1) and the procedure for ordering them shall be publicly available on the free access website of the manufacturer, importer or authorised representative, at the latest two years after the placing on the market of the first unit of a model and until the end of the period of availability of these spare parts. (5) The list of spare parts concerned by point (2) and the procedure for ordering them and the repair instructions shall be publicly available on the manufacturer's, the importer's or authorised representative's free access website, at the moment of the placing on the market of the first unit of a model and until the end of the period of availability of these spare parts. (b) Maximum delivery time of spare parts During the period mentioned under point (a), the manufacturer, importer or authorised representatives shall ensure the delivery of the spare parts for refrigerating appliances with a direct sales function within 15 working days after having received the order. In the case of spare parts available concerned by point a(1) the availability of the spare parts may be limited to professional repairers registered in accordance with point c(1) and (2).

Ecodesign Regulation	Main rules/criteria
	(c) Access to repair and maintenance information After a period of two years after the placing on the market of the first unit of a model or of an equivalent model, and until the end of the period mentioned under (a), the manufacturer, importer or authorised representative shall provide access to the appliance repair and maintenance information to professional repairers in the following conditions: (1) the manufacturer's, importer's or authorised representative's website shall indicate the process for professional repairers to register for access to information; to accept such a request, manufacturers, importers or authorised representative may require the professional repairer to demonstrate that: (i) the professional repairer has the technical competence to repair refrigerating appliances with a direct sales function and complies with the applicable regulations for repairers of electrical equipment in the Member States where it operates. Reference to an official registration system as professional repairer, where such system exists in the Member States concerned, shall be accepted as proof of compliance with this point; (ii) the professional repairer is covered by insurance covering liabilities resulting from its activity regardless of whether this is required by the Member State. (2) the manufacturers, importers or authorised representatives shall accept or refuse the registration within 5 working days from the date of the request; (3) manufacturers, importers or authorised representatives may charge reasonable and proportionate fees for access to the repair and maintenance information or for receiving regular updates. A fee is reasonable if it does not discourage access by failing to take into account the extent to which the professional repairer uses the information. Once registered, a professional repairer shall have access, within one working day after requesting it, to the requested repair and maintenance information. The information may be provided for an equivalent model or model of the same family, if relevant. The available repair and maintenance information shall include: • the unequivocal appliance identification; • a disassembly map or exploded view; • technical manual of instructions for repair; • list of necessary repair and test equipment; • component and diagnosis information (such as minimum and maximum theoretical values for measurements); • wiring and connection diagrams; • diagnostic fault and error codes (including manufacturer-specific codes, where applicable); • instructions for installation of relevant software and firmware including reset software; and • information on how to access data records of reported failure incidents stored on the refrigerating appliance with a direct sales function (where applicable). (d) Requirements for dismantling for material recovery and recycling while avoiding pollution (1) Manufacturers, importers or authorised representatives shall ensure that refrigerating appliances with a direct sales function are designed in such a way that the materials and components referred to in Annex VII to Directive 2012/19/EU can be removed with the use of commonly available tools. (2) Manufacturers, importers and authorised representatives shall fulfil the obligations laid down in point 1 of Article 15 of Directive 2012/19/EU. (3) If the refrigerating appliances with a direct sales function contains vacuum insulation panels, the refrigerating appliance with a direct sales function shall be labelled with the letters 'VIP'.

Ecodesign Regulation	Main rules/criteria
	Information requirements: (e) instructions for the correct installation and end-user maintenance, including cleaning, of the refrigerating appliance with a direct sales function; (f) for integral cabinets: 'If the condenser coil is not cleaned [the recommended frequency for cleaning the condenser coil, expressed in times per year], the efficiency of the appliance will decrease significantly.'; (g) access to professional repair such as internet webpages, addresses, contact details; (h) relevant information for ordering spare parts, directly or through other channels provided by the manufacturer, importer or authorised representative such as internet webpages, addresses, contact details; (i) the minimum period during which spare parts, necessary for the repair of the refrigerating appliance with a direct sales function, are available; (j) the minimum duration of the guarantee of the refrigerating appliance with a direct sales function offered by the manufacturer, importer or authorised representative;
Commission Regulation (EU) 2019/1784 (welding equipment)	**2. Resource efficiency requirements** From 1 January 2021, welding equipment shall meet the following requirements: (a) Availability of spare parts (1) Manufacturers, authorised representatives or importers of welding equipment shall make available to professional repairers at least the following spare parts for a minimum period of 10 years after the production of the last unit of a welding equipment model: (a) control panel; (b) power source(s); (c) equipment housing; (d) battery(ies); (e) welding torch; (f) gas supply hose(s); (g) gas supply regulator(s); (h) welding wire or filler material drive; (i) fan(s); (j) electricity supply cable; (k) software and firmware including reset software. (2) Manufacturers shall ensure that these spare parts can be replaced with the use of commonly available tools and without permanent damage to the equipment and the part. (3) The list of these spare parts and the procedure for ordering them shall be publicly available on the free access website of the manufacturer, authorised representative or importer, at the latest two years after placing on the market of the first unit of a model and until the end of the availability of these spare parts. (b) Access to repair and maintenance information No later than two years after the placing on the market of the first unit of a model, and until the end of the period mentioned under point a.1, the manufacturer, importer or authorised representative shall provide access to the welding equipment repair and maintenance information to professional repairers in the following conditions: (1) the manufacturer's, authorised representative's or importer's website shall indicate the process for professional repairers to register for access to information; to accept such a request, manufacturers, authorised representatives or importers may require the professional repairer to demonstrate that:

Ecodesign Regulation	Main rules/criteria
	(i) the professional repairer has the technical expertise to repair and maintain welding equipment and complies with the applicable regulations for repairers of electrical equipment in the Member States where it operates. Reference to an official registration system as professional repairer, where such system exists in the Member States concerned, shall be accepted as proof of compliance with this point; (ii) the professional repairer is covered by insurance covering liabilities resulting from its activity regardless of whether this is required by the Member State; (2) the manufacturer, authorised representative or importer shall accept or refuse the registration within 5 working days from the date of request by the professional repairer. Once registered, a professional repairer shall have access, within one working day after requesting it, to the requested repair and maintenance information. The information may be provided for an equivalent model or model of the same family, if relevant. The available repair and maintenance information shall include: • the unequivocal welding equipment identification information, • a disassembly map or exploded view, • a list of necessary repair and test equipment, • component and diagnosis information (such as minimum and maximum theoretical values for measurement), • wiring and connection diagrams, • diagnostic fault and error codes (including manufacturer-specific codes where applicable), • data records of reported failure incidents stored in the welding equipment (where applicable), and • instructions for installation of relevant software and firmware including reset software. Manufacturers, authorised representatives or importers may charge reasonable and proportionate fees for access to the repair and maintenance information or for receiving regular updates. A fee is reasonable if it does not discourage access by failing to take into account the extent to which the professional repairer uses the information. (c) Maximum delivery time for spare parts During the period mentioned under point a.1, the manufacturer, importer or authorised representative shall ensure the delivery to professional repairers of spare parts for welding equipment within 15 working days after having received the order. This availability may be limited to professional repairers registered in accordance with point (b). (d) Information on the display of welding equipment Where a display is provided for a welding equipment it shall provide indication of the use of welding wire or filler material in grams per minute or equivalent standardised units of measurement. (e) Requirements for dismantling for material recovery and recycling while avoiding pollution Manufacturers shall ensure that welding equipment are designed in such a way that the materials and components referred to in Annex VII to Directive 2012/19/EU can be removed with the use of commonly available tools. Manufacturers shall fulfil the obligations laid down in point 1 of Article 15 of Directive 2012/19/EU

Affordable and Clean Energy

The Swedish Energy Agency is leading society's transition to a sustainable energy system.

We contribute with facts, knowledge, and analysis of supply and use of energy in the society, as well as work towards security of energy supply.

Research on new and renewable energy technologies, smart grids, as well as vehicles and transport fuels of the future receives funding from us. We also support business development that allows commercialisation of energy related innovations, and ensure that promising cleantech solutions can be exported.

Official energy statistics, and the management of instruments such as the Electricity Certificate System and the EU Emission Trading System, are our responsibility.

Furthermore, we participate in international collaboration with the aim of attaining Swedish energy and climate objectives, and develop and disseminate knowledge for a more efficient energy use to households, industry, and the public sector.

Swedish Energy Agency

Swedish Energy Agency, P.O. Box 310, 631 04 Eskilstuna, Sweden
Phone +46 16-544 20 00, Fax +46 16-544 20 99
E-mail registrator@swedishenergyagency.se
www.swedishenergyagency.se