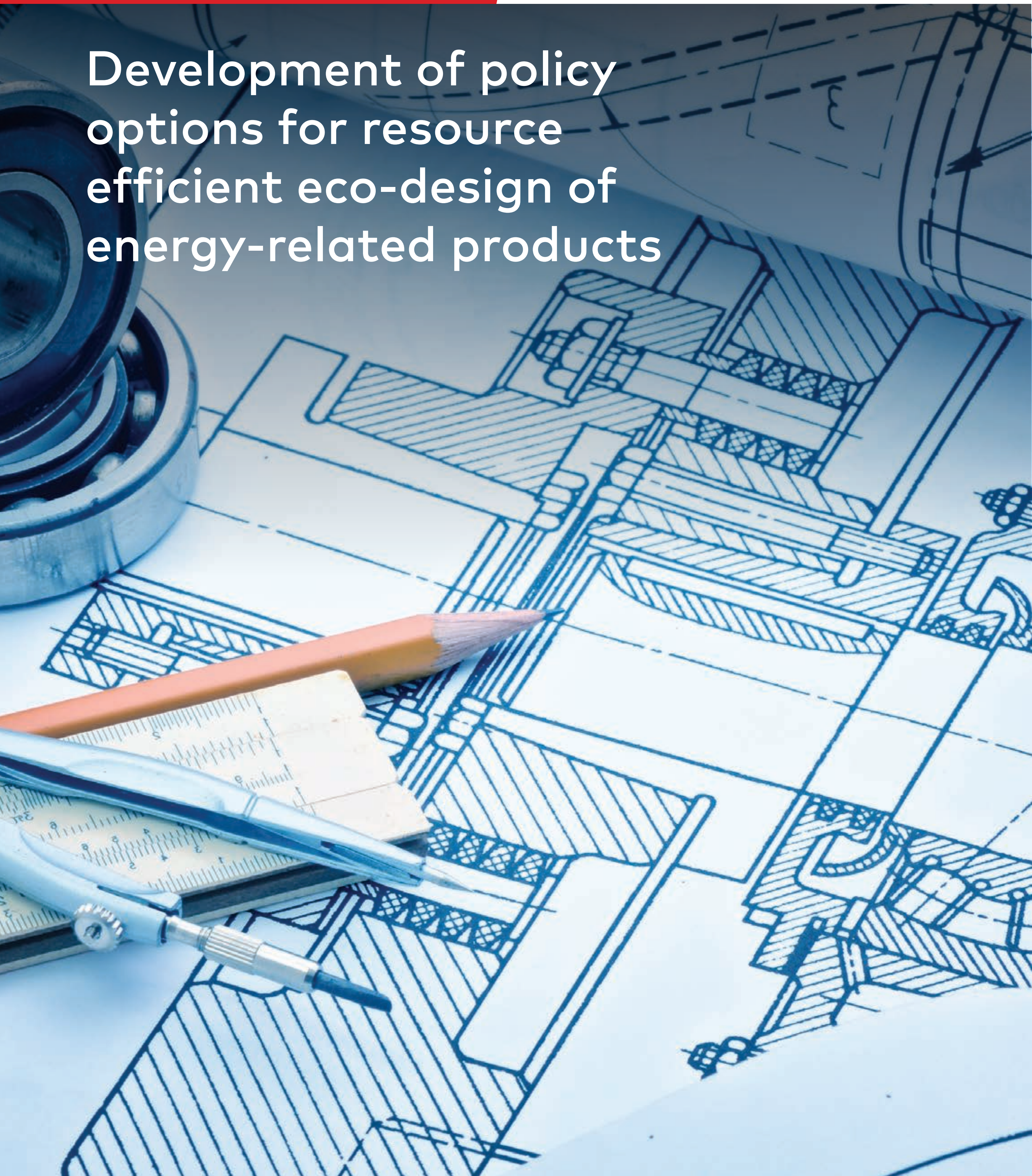
Development of policy options for resource efficient eco-design of energy-related products



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Protect. Transform. Sustain.

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Acronyms

Acronym	Explanation
AATF	Approved authorised treatment facility
Defra	Department of food, environment and rural affairs
DRS	Deposit Return System
EOL	End-of-Life
EPR	Extended Producer Responsibility
EEE	Electric and Electronic Equipment
GHG	Greenhouse gas
PCS	Producer Compliance Scheme (see also PRO)
POM	Placed on Market
PRO	Producer Responsibility Organisation (see also PCS)
WEEE	Waste Electrical and Electronic Equipment
WG	WEEE generated

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Executive Summary

Defra is responsible for developing policy to address the resource efficiency of energy-related products (ErP). **A question remains as to whether eco-modulation, eco-design, eco-labelling, or some combination of these, is the best approach to improving the resource efficiency of ErP**.

The overarching objective is to **reduce the environmental impact of ErP** across the lifecycle with particular focus on production and disposal, by using measures that either reduce the amount of ErPs that become waste or ensure optimal treatment routes when ErPs do become waste. This extends to measures which help ensure ErP which does become waste is recycled at maximum value, i.e. as many materials as possible are recovered and recirculated, reducing demand for virgin extraction.

Defra is looking to **explore ways to reduce waste arisings by enabling resource efficiency**. Whilst the role of better eco-design has been considered as an aim within eco-modulation, some focussed exploration of the role of eco-design in its own right is also needed.

This report is a summary of the exploration conducted within a 3-month period from May – August 2022. The objectives were to **identify the ErP that are responsible for the greatest impact** in terms of waste arisings, embodied lifecycle emissions and consumption of natural resources through the creation of a prioritisation tool. The tool in turn was to identify where **the opportunity exists to reduce key impacts and how eco-design measures can be most effective. Possible trade-offs** and unintended consequences involved were considered as well as other influencing factors such as **the role of the consumer**.

Following a detailed assessment of the potential inductors, **Put On Market (POM), WEEE Generated**[1] **(WG) and Carbon Footprint** are identified as the **most suitable indicators** to prioritise energy-related products for policy intervention to reduce their lifecycle environmental impact, focusing on production and disposal. Application of these indicators, resulted in identification of products that ranked high on both indicators:

1 Sum of all WEEE Generated, including WEEE collected separately as well as WEEE that escapes separate collection e.g. thrown out in residual waste, treated as scrap metal or exported for reuse.

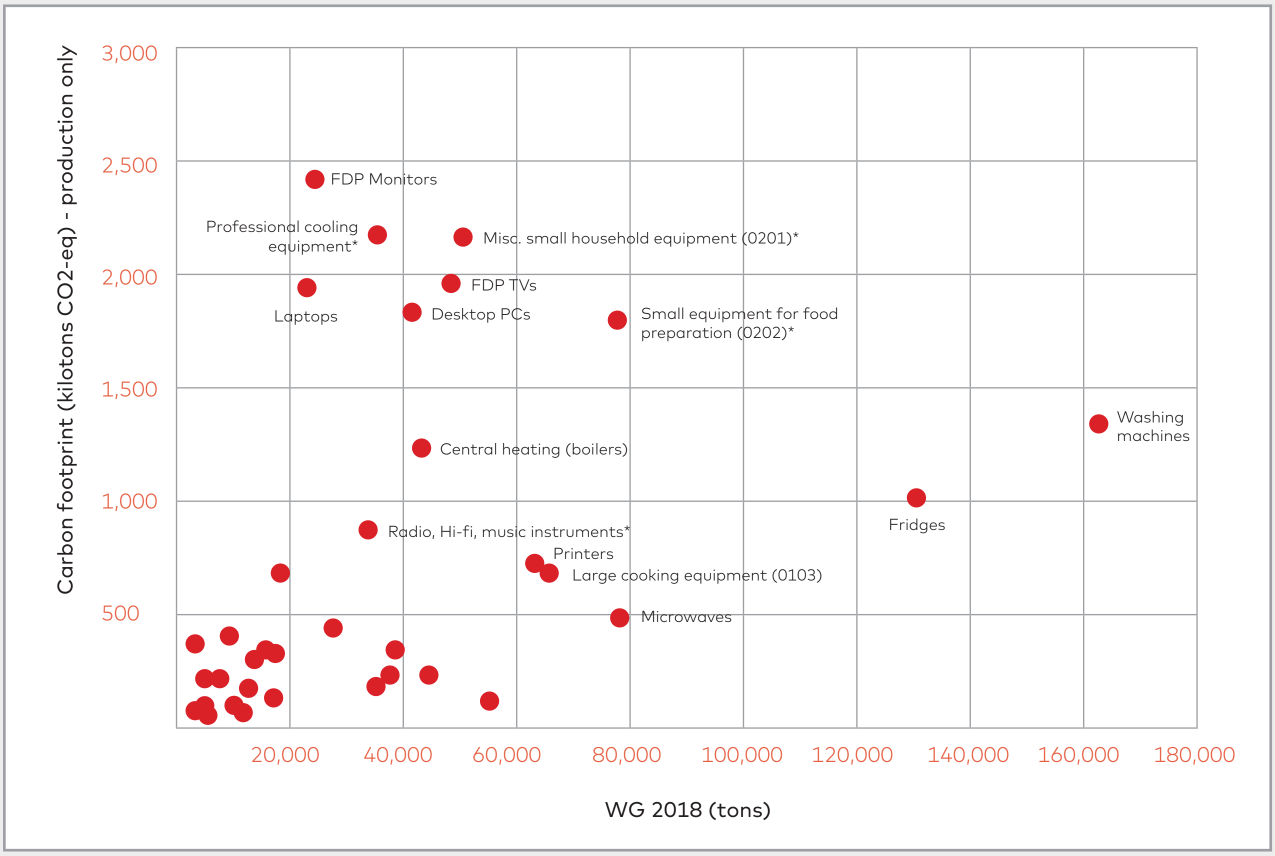


Figure 1: WEEE Generated (WG) and Carbon Footprint (CF) of products for which LCA (Life Cycle Analysis) data is available. Products marked with an asterisk: Carbon Footprint data based on closest-match due to missing specific data[2].

This prioritisation exercise demonstrates that the outlying products that feature highly on the CF axis are mainly ICT equipment such as laptops, monitors and TVs, PCs and small appliances. Outlying products on the WG axis are large domestic appliances such as fridges and washing machines. This is related to the "electronic-richness" of appliances, as electronic components make use of scarce metals which are associated with large environmental impacts during their production. Contrasting Figure 1 against **the products that do not have any UK or EU Eco-design legislation** applied to them, highlights small equipment for food preparation (e.g. toaster, grills, food processors, hot plates, fryers), microwaves and printers (e.g. scanners, multi functionals, faxes). These represent key potential areas of focus for eco-design policy opportunities.

In aligning our work with that of BEIS, **an additional two products were highlighted as priority in the UK: domestic cookers and space heaters (which includes conventional gas boilers, hydrogen-ready boilers and hybrid boiler and heat pump systems).** A number of stakeholder engagement interviews were conducted to explore views of potential regulatory options, including spare part availability which has been applied to other product categories such as washing machines and fridges. A number of insights were gained:

- For domestic cookers, there is a well-established spare parts industry and thus mandatory provision of spare parts is unlikely to improve existing life-extension beyond standardising existing best practice. There is potential greater impact through UK legislation **to encourage the creation of a take-back and refurbishment sector for domestic cookers to keep resources in use for longer**. Current barriers to this are the inability to return machines to overseas manufacturers for refurbishment and with appliance transport mainly being outsourced to a third party, it is not commercially viable to collect old or faulty appliances for refurbishment.

2 Data for 0203 used as proxy for 0202; data for 0204 used as proxy for 0201; data for 0001 used as proxy for 0113; data for 0405 used as proxy for 0403.

- In discussions with the space heater industry, the suggestion of a spare part requirement for the sector was widely agreed with and accepted. Formalising spare part availability into UK regulation **would provide certainty and transparency with regard to the availability of spares for a fixed period of time,** wherein both repair engineers and consumers would know the likelihood of ability to fix faults. **The role of the repair engineer** is key in providing expert advice to consumers as to the cost effectiveness and feasibility of repair or, if necessary, the type and specification of a replacement boiler. **Engineers need to be furnished with all the information of new technologies to best advise the customer**.

- There is a balance between **extension of existing boiler life versus application of new technologies** that are more energy efficient. However, modern boilers are more complex and contain more technical parts, thus increasing the risk of component failure and need to repair as well as a risk of component obsolescence as electronic technology advances. The industry is technologically at a time of great flux and **the future is uncertain**. **Advocacy of a hybrid boiler was supported** by those interviewed as a stepping-stone to phasing out of old boilers to the new technology at the natural replacement cycle of a boiler system. However, this needs to be recognised and **supported by regulations and investment**.

When considering potential eco-design measures, the aim is making products better, and thus, inter alia, also to last longer and be more repairable. This in turn reduces impact on the planet in terms of resource consumption. The potential and implications of interventions aiming at **extending the lifetime of energy-related products** was therefore explored. Data analysis on impacts of lifetime extension on quantities of product placed on the market as well as waste generated was conducted. The analysis is based on a mathematical model that links quantities put on the market (POM), lifetime distributions (obsolescence rates, expressed as Weibull distribution) and WEEE generated (WG).

Applied to 17 products (representing more than 80% of total POM), the simulated scenario (20% market share for products with a 50% longer lifetime) results in a **10% diminution in POM over the period 2020-2030, and a 6% reduction in WG over the same period. Impacts of lifetime extensions are highest for products with a rapidly increasing market share and relatively shorter lifetimes, and lowest for products with stable POM and long-baseline lifetimes**. Policy interventions aimed at extending lifetimes to reduce environmental impacts related to POM and WG should therefore target priority products belonging to the first category.

Whilst this simulation demonstrates a delay in impact and only a small percentage of reduction in waste generated, it should be noted that a number of simplifying assumptions were made. The extension of life by an **average lifespan 50% longer** is potentially high and also it is acknowledged that it would take time to develop a **20% market share**. Similarly, product sales are likely to fluctuate rather than remain at a constant level (as was assumed in the modelling) especially as buying habits are impacted by events such as Covid 19 and increased cost of living.

With the most recent EU and UK legislative **measures focussing on ensuring the availability of spare parts to encourage repairability**, how this was viewed and implemented by industry was first investigated. This in turn led to the **exploration of the impact of longer guarantees as standard and in turn the role of eco-labelling**.

In order to understand the financial, practical and resource impact that keeping spare parts available entails, **a number of stakeholder discussions were held. The cost of producing, selling, storing and maintaining an up-to-date provision of spare parts is a significant undertaking** for all those interviewed but the percentage of spare parts ordered and then used was found to be high. Providing spare parts is seen by all producers interviewed as **a necessary service from a product quality point of view as well as from that of brand perception**. The cost of a repair that is made up of part, labour and transport and especially **for market entry products, if the product is not under guarantee or extended warranty, there is no economic viability of fixing** a product versus buying a new one. The time that parts are held in stock is not pre-determined (unless specified in existing Ecodesign regulations) and is currently decided based on the length of maintenance contracts and extended warrantee periods offered.

Encouraging repairability through mandatory availability of spare parts for product categories such as large domestic appliances and laptops where there already is an established, independent repair industry is unlikely to increase the number of products remaining in use in those categories. **The regulatory requirement for spare part availability should not be applied as a default but instead be assessed per product category with consideration given to factors including maturity of the category, level of anticipated impact on life extension and environmental impact of making spare parts**.

Products under standard guarantee were more readily repaired by consumers as it is a free service and seen as an easy option. However, the extension of a standard guarantee to 7 or 8 years rather than 1 or 2 is **generally not supported by those from industry interviewed on economic, social and practical grounds. Longer guarantees as standard might be feasible where repair is currently not so prevalent** due to low value of the product or the lack of infrastructure of parts and independent engineers.

The Repairability Index in France was assessed to better understand the impact of eco-labels. Analysis showed that the Repairability Index seems to be **a promising tool to incentivise the design** of more repairable and therefore longer-lasting products. It is well received by both consumers and producers and has the potential to be used along with energy efficiency labels as a simple, visible, purchasing guidance for consumers.

The consumer decision to repair or replace is a key influencing factor regarding longevity of use of a product; regardless of how repairable a product is, or the cost or availability of spare parts. **Cost and convenience are still the main two criteria for consumers** in the buying decision. Given awareness by the consumer is such a pivotal part of keeping products in use for longer, **labelling was shown to be a critical information point**. The consumer group interviewed surveyed a sample of 821 of its members after engaging with sustainability information on dishwashers and washing machines and 95% said they found it either very or fairly helpful as part of their decision-making. This shows the educational benefit of product information at point of purchase – especially in supporting the uncertain/unmotivated consumers and that the **need to inform and influence the consumer is a key area for further investigation**.

The complexity and multitude of inter-related aspects makes the challenge of encouraging resource efficiency within the ErP sector, **a complicated challenge where addressing one aspect can have a number of unintended or interconnecting impacts**. These include

- Energy efficiency vs resource efficiency
- Innovation vs product cost
- Repairability vs customer convenience
- Maturity of product category vs regulatory demands
- UK legislation vs EU legislation

To conclude, when assessing how eco-design measures can reduce the environmental impacts of ErP, it depends on the metric used for measurement of success (WG or CF) and the anticipated timescales:

Reducing WG - Physical design changes required by eco-design regulations will not actually start to impact on WG of new products for, depending on product lifetimes and including the time to implement regulations, **a minimum of 6/7 years** for products with relatively short lifespans of **3-5 years** such as smartphones, peripherals, and laptops or longer for products with longer lifespans. Design requirements to enable better recovery of materials and components at end-of-life reduces waste and has an additional CF benefit but also have **a longer time to realise the benefit**. Requirements intended to **extend the lifetimes of existing stock are therefore clearly preferable as these can have a more immediate impact**.

Reducing CF - **Eco-design requirements focussed on the physical design and production**, through decarbonisation of materials and processes, **have the potential to directly reduce the carbon footprint of EEE in a shorter timeframe**. As most EEE is imported, such measures would only contribute minimally to the UK's Net Zero targets, however they would support the global need to address carbon emissions.

Lifetime extension measures for products that have the highest CF and WG that are already on the market would have maximum impact in the shortest timescale. The provision of information on product repairability (on existing stock as well as new products) therefore needs to be communicated through an effective use of labelling, as is currently done for energy efficiency of products. **Consumer education and awareness is key** to keeping products in use for longer through repairability or choice of the right product when purchasing.

However, the product categories within ErP are very different and **one approach does not suit the whole sector**. Activities that might need to be encouraged for one category of products can be commonplace established practice in another. **Regulatory policies therefore need to reflect this nuance** and tailor the approaches needed depending on a multitude of factors. These include the complexity of the product category, whether the technology is new or established, the maturity of the market, other prevalent policy requirements such as safety that take priority and the infrastructure that is in place for repair or recycling.

Another more immediate way of delivering impact would be for eco-design regulations to **offer minimum standards** that a producer must comply with. These regulations need to be clear and facilitate direct action such as setting a minimum operational lifetime that is supported by repairability or legislating against materials or other design aspects that hinder the repairability of products. Products under guarantee or extended warrantee are more likely to be repaired so the requirement to offer **spare parts supports the expansion of this scenario**. For product categories that already offer lengthy availability of spare parts, regulating on spare parts will formalise existing best practice and set an industry standard. For **product categories that have a lower product value and low economic repair value, this would be ground-breaking territory** – such as toasters and food processors. However, the challenge here will be to make this economically viable.

1 Introduction

1.1 Background

Defra is responsible for developing policy to address the resource efficiency of energy-related products (ErP). **A question remains as to whether eco-modulation, eco-design, eco-labelling, or some combination of these, is the best approach to improving the resource efficiency of ErP.**

By resource efficiency, in this context, what is meant is **primarily the consumption of resources throughout the product lifecycle** but excluding operational energy and water usage.

The overarching objective is to **reduce the environmental impact of ErP** across the lifecycle with particular focus on production and disposal, by using measures that either reduce the amount of ErPs that become waste or ensure optimal treatment routes when ErPs do become waste. This extends to measures which help ensure ErP which does become waste is recycled at maximum value, i.e. as many materials as possible are recovered and recirculated, reducing demand for virgin extraction.

In the Energy-related Products Policy Framework (PPF), published November 2021, **the Government committed to introducing similar requirements for more products** to those recently put in place relating to spare parts availability and information for repairers (the 'right to repair' elements of the most recently laid Eco-Design Regulations), **provided the evidence supports that approach**.

In the PPF, plans were also set out to explore more ambitious measures to enable reuse, repair and remanufacture, including design for disassembly.

Defra is looking to **explore ways to reduce waste arisings by enabling resource efficiency.** Whilst the role of better eco-design has been considered as an aim within eco-modulation, some focussed exploration of the role of eco-design in its own right is also needed.

1.2 Project Objectives

i. **identify the ErP that are responsible for the greatest impact** in terms of waste arisings; embodied lifecycle emissions and consumption of natural resources (in particular those that are 'critical'), as well as other impacts to nature throughout the lifecycle.

ii. establish that, for the products identified, **the opportunity exists to reduce key impacts** including but not limited to measures that extend product and material lifetimes: durability, repairability and recyclability, as well as suitability for remanufacturing.

iii. **recommend the optimal blend of policies** and specifically what outcomes eco-design is likely to be most effective at delivering:
   a. **are eco-design and eco-modulation both suited to achieving the same outcomes**, or different ones? Consider the answer to this question within the parameters of the existing UK WEEE system, but also with the potential to change the existing UK scheme.
   b. **is a combination of eco-design and eco-modulation likely to be an effective approach**, or should one or the other be used?
   c. What role, if any, might mandatory eco-labelling play as an alternative or complementary approach

iv. **indicate other factors necessary to bring about the desired outcome** (less e-waste and a reduced environmental impact of ErP) that may not be influenced by eco-design alone, e.g. consumer behaviours

v. **identify possible trade-offs** and unintended consequences, for example
   a. greater resource efficiency at the cost of (operational) energy efficiency
   b. Likely price impacts, including due to implications for international trade

vi. **assess the suitability of the current "right to repair" eco-design provisions** (spare part availability, info for repairers, etc) for inclusion in future regulations.

1.3 Key Definitions

Eco-design: Eco-design considers environmental aspects at all stages of the product development process, striving for products which make the lowest possible environmental impact throughout the product lifecycle. In the context of this research, proposed eco-design measures should ideally be realizable within the existing regulatory framework, namely the Ecodesign for Energy-related Products Regulations 2010.

Eco-modulation: Under a modulated fee/obligation approach within an extended producer responsibility (EPR) scheme, fees or obligations may vary according to specific criteria relating to aspects of producers' products' environmental performance, incentivizing eco-design. Eco-modulation and eco-design are closely linked, in that both are means of bringing about more sustainable (eco) product design.

Eco-labelling: often used loosely to describe the provision of information with products pertaining to their environmental credentials or performance. A more accurate definition includes the requirement that qualification for an eco-label is independently assessed and therefore quality assured. Within Government and in the context of products policy, 'product information' is being used to describe the provision of information about environmental credentials with the intention to influence consumer and/or business behaviour.

Electrical and electronic equipment (EEE): *"equipment which is dependent on electric currents or electro-magnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields designed for use with a voltage rating not exceeding 1000 volts for alternating current and 1500 volts for direct current"* (WEEE Directive (2012/19/EU), Article 3).

Energy-related product (ErP): *"any good that has an impact on energy consumption during use which is placed on the market and/or put into service, and includes parts intended to be incorporated into energy-related products covered by this Directive which are placed on the market and/or put into service as individual parts for end-users and of which the environmental performance can be assessed independently"* (Eco-design Directive (2009/125/EC), Article 2). **In addition to energy-using products (EEE), ErP also include products that do not use energy but have an indirect impact on energy consumption, such as windows, taps and showers and building insulation panels.**

1.4 Methodology

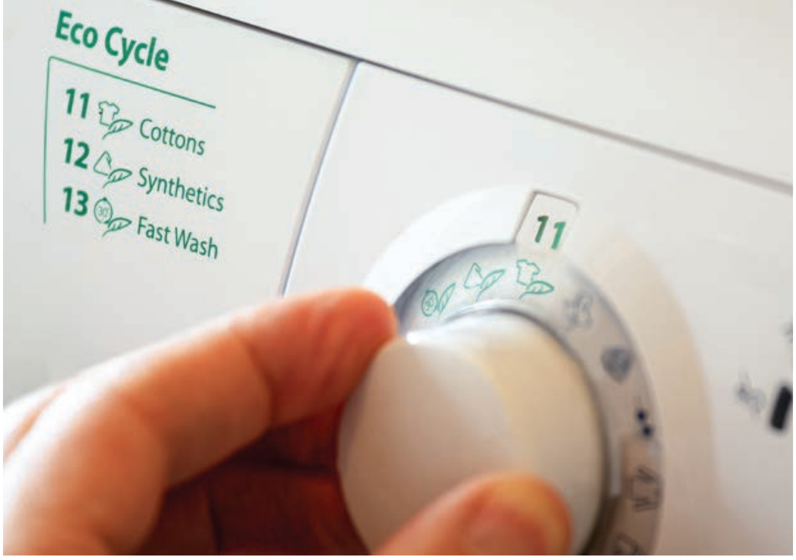
We undertook a number of tasks using a combination of desk research, data collection and analysis and stakeholder interviews:

Task 1 – Prioritisation of products

Energy-related products consist of a wide variety of product types and models that differ in terms of sales volumes, weight, material composition, lifetime, repairability and recyclability. These differences in characteristics directly influence the environmental impacts that these products may have throughout their lifecycle. Given this high level of complexity, and in the context of policy interventions to reduce the environmental impacts of ErPs, it is important to prioritise products based on relevant indicators and robust data sources.

The main objective was thus to **develop a robust and repeatable methodology to identify ErPs linked to the largest environmental impacts** (related to the production and end-of-life stages) that policy interventions can tackle in priority. The scope encompassed all products that can become WEEE at end-of-life, noting however that the relevant regulatory framework, Ecodesign for Energy-related Products 2010, applies to a slightly broader range of products, some of which do not use energy but have an indirect impact on energy consumption, such as water using devices, building insulation products, windows, etc.

Using datasets from various sources, **a set of environmentally relevant indicators were created** and agreed upon to create an Excel tool that, depending on the weighting of different criteria, **enable recommendations to be made** by identifying the products requiring attention first.



As an Excel tool, it has been designed to be updated as new data becomes available and so be revisited and **used into the future to identify priority products or product groups, as well as highlight emerging trends.**

To support this task, a review of the methodologies used elsewhere to support product selection for eco-design / eco-modulation requirements on resource efficiency was also conducted. This ensured that **existing approaches were considered and contrasted against our approach** – to see where there was an alignment or differences in the products that were highlighted as a priority for action.

Task 2 – Exploration of life-extension potential & implications

An assessment, through a limited number of case studies with industry of the business dynamics behind repair, with assessment of average number of Stock Keeping Units (SKU) per product type and model, the current average time SKU are maintained and the financial impact of keeping in stock un-necessary spare parts was conducted. This also allowed for the **assessment of the right balance between the "right to repair" provisions** and the impact on environment and the likelihood that those measures will help extend the lifetime of products.

The work of Defra interlinks greatly with that of BEIS. In collaboration with BEIS's own prioritisation tasks, **two specific product categories for consideration of the application of eco-design measures became apparent – domestic cookers and space heaters**. Building on the stakeholder engagement work already conducted, it was possible to extend discussions to these two industries to gauge their views on possible measures – be it availability of spare parts or more innovative suggestions.

Task 3 – The role of the consumer as an influencing factor

Whilst eco-design measures (and eco-modulation) are product-related measures, **the exploitation of the benefits cannot be decoupled from the role that consumers must play** in minimising waste. In this task an interview with a UK consumer association enabled the evaluation of the potential effect of alternative measures (e.g. labelling, information campaigns like for Energy Label) could also have on the achievement of the resource efficiency strategy.

Task 4 – Analysis of trade-offs

Any measures that might be applied to ErP will incur potential side effects or conflicting priorities. Some of the key conflicting considerations are analysed which in turn highlights the complexity and inter-related nature of any levels of considered intervention.

This leads to **the identification of some potential "low hanging fruit"** regarding possible priority product categories and consideration that Defra can explore further through industry engagement and public consultations.

2 Prioritisation of Products

2.1 Indicators

Energy-related products consist of a wide variety of product types and models that differ in terms of sales volumes, weight, material composition, lifetime, repairability and recyclability. These differences in characteristics directly influence the environmental impacts that these products may have throughout their lifecycle. Given this high level of complexity, and in the context of policy interventions to reduce the environmental impacts of ErPs, it is **necessary to prioritise products based on relevant indicators and robust data sources**.

The main objective was to develop a **robust and repeatable methodology to identify ErPs linked to the largest environmental impacts** (related to the production and end-of-life stages) that policy interventions shall tackle in priority.

Using datasets from various sources, a **set of environmentally relevant indicators** was created and agreed upon, and integrated into an Excel tool that, depending on the selection and weighting of indicators, enable ranking of products according to their impact. This **Excel tool** was designed to be easily updated as new data becomes available, so that it can be revisited in the future to identify priority products or product groups, as well as highlight emerging trends.

The **scope in terms of products** is everything that is treated as WEEE once it becomes waste.

The **selection of indicators** was driven by the following considerations:
- Alignment with Defra's Resources and Waste Strategy (focus on production and end-of-life);
- Availability of data and information of sufficient quality and scope;
- Focus on absolute (UK-wide) rather than relative (per product unit) environmental impacts.

The **resulting set of indicators** is described in the following table:

#	Indicator	Lifecycle stage	Data source & methodology	Remarks on data availability, quality and coverage
1	POM – Put on the market (t): Quantity of EEE placed each year on the UK market, in tons	Production		Data available for all types of EEE, classified using the "UNU-KEY" nomenclature (54 categories)[5] Data based on international trade and production statistics, which can be considered quite reliable WG data is more uncertain than POM data, as it is the result of mathematical modelling assuming certain lifetime distributions
2	POM (u): quantity of EEE placed each year on the UK market, in units	Production	"Waste over Time" methodology[3], which applies EU's "common methodology" to calculate POM and WG[4]	
3	WG – WEEE generated(t): quantity of WEEE generated each year in the UK, in tons	End-of-life		
4	WG (u): quantity of WEEE generated each year in the UK, in units	End-of-life		
5	Estimated collection rate	End-of-life	Collection rates were calculated for each of the 14 UK WEEE categories based on: - Tons of WEEE separately collected in the UK[6] - Tons of WEEE generated in the UK according to indicator #3 Collection rate for each UK category was applied to all UNU-KEY it contains	Collection rate at the UK category level can be considered quite reliable, however becomes more uncertain when broken down at UNU-KEY level

3 https://github.com/Statistics-Netherlands/ewaste
4 Commission Implementing Regulation (EU) 2017/699 of 18 April 2017 establishing a common methodology for the calculation of the weight of electrical and electronic equipment (EEE) placed on the market of each Member State and a common methodology for the calculation of the quantity of waste electrical and electronic equipment (WEEE) generated by weight in each Member State
5 The UNU-KEY nomenclature was developed by the United Nations University to provide a limited number of categories that reflect similarities between appliances in terms of function, lifespan, unit weight, and end-of-life outlets. The UNU-KEY nomenclature is established within the EU regulatory framework, being used in the WEEE calculation tools (WCT) published by the European Commission: https://environment.ec.europa.eu/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee/implementation-weee-directive_en.
6 https://www.gov.uk/government/statistical-data-sets/waste-electrical-and-electronic-equipment-weee-in-the-uk

<table>
<thead>
<tr><th>#</th><th>Indicator</th><th>Lifecycle stage</th><th>Data source & methodology</th><th>Remarks on data availability, quality and coverage</th></tr>
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<tbody>
<tr><td>6</td><td>Carbon Footprint of production (kg CO2-eq)</td><td>Production</td><td>Database: ecoinvent 3.8
Indicator: Global Warming Potential 100a
Scope: cradle-to-gate</td><td rowspan="3">Specific LCA data available for 67% of products in terms of tons POM. Closest match applied for another 21%, bringing the total coverage to 90% of total POM

Although ecoinvent data is intended to provide average and representative data, inherent limitations of LCA data availability and representativeness call for caution when using these figures. The real impact of a specific product model may be considerably higher or lower than the generic ecoinvent figure</td></tr>
<tr><td>7</td><td>Abiotic Depletion Potential of production (kg Sb-eq)[7]</td><td>Production</td><td>Database: ecoinvent 3.8
Indicator: "abiotic depletion potential" from CML v4.8 2016
Scope: cradle-to-gate</td></tr>
<tr><td>8</td><td>Aggregated environmental impact of production (total ReCiPe points)[8]</td><td>Production</td><td>Database: ecoinvent 3.8
Indicator: ReCiPe H,A total
Scope: cradle-to-gate</td></tr>
<tr><td>9</td><td>Critical Raw Material (CRM) score</td><td>Production</td><td>Semi-quantitative score based on:
- List of "key CRM-containing equipment" developed within the H2020 CEWASTE project[9], identifying WEEE types that should be targeted in priority in order to recover CRMs in Europe.
- Data on CRM content for a selection of products from report "Contributing towards a CE utilising CRM from Waste Electricals" (July 2021 by Material Focus)</td><td>Low data availability, and high variability between models depending on year of manufacture</td></tr>
<tr><td>10</td><td>Problematic Substances Score</td><td>Production</td><td>Semi-quantitative score based on own experience as WEEE auditor</td><td>Low data availability, and high variability between models depending on year of manufacture (due to gradual introduction of substances restrictions and eco-design requirements)</td></tr>
</tbody>
</table>

7 This indicator is made up of two elements: the relative rate of extraction of the resource and the size of those reserves. When you remove 1 kg of material X which has a global reserve of 1000 kg, for example, this extraction represents 0.1% of your global resource, which is huge. And because you have a very small reserve, your material X will have a much bigger impact. Antimony ("Sb") is used as reference substance for arbitrary reasons, however relative scores of different materials/products won't change by choosing another reference substance.

8 ReCiPe is a life cycle impact assessment (LCIA) method, the most widely used one worldwide (https://www.ipoint-systems.com/blog/lcia-indicator/). It is made of 18 "midpoint" indicators that express life cycle inventory results into a limited number of environmental impact indicators. These 18 "midpoint" indicators can then be grouped into 3 "endpoint" indicators which in turn can be aggregated into a single "total" score. This implies weighting of different impact categories, which introduces value judgment and should therefore be used with care (https://pre-sustainability.com/articles/weighting-applying-a-value-judgement-to-lca-results/)

9 https://cewaste.eu/wp-content/uploads/2021/04/210409_Cewaste_Table.pdf

#	Indicator	Lifecycle stage	Data source & methodology	Remarks on data availability, quality and coverage
11	Simplified end-of-life gross carbon footprint (kg CO2-eq)	End-of-life	Composite indicator made of: - Gross carbon footprint of WEEE collection and treatment in the UK, according to Bond, M. 2022[10] (substitution credits not included) - Estimated carbon footprint of small WEEE ending up in the bin and being incinerated (assumptions on plastic content and share of appliances ending up in incineration in the UK)	Calculable for all WEEE categories however with high uncertainties due to being a simplified assessment based on sparse data

Table 1: Considered prioritisation indicators

The indicators listed above were calculated for all 54 UNU-KEYs, provided that necessary data was available. For some indicators, data availability was high, and indicators could be calculated for all equipment types, for others data was scarce so that only a subset of equipment categories could be scored. In addition, the environmental relevance of the indicators, i.e., the extent to which a high score actually represents a high environmental impact in absolute terms, varies. Below, indicators are grouped according to their environmental relevance and data availability/quality.

High environmental relevance and high data availability/quality:

- **POM in tons:** arguably the simplest and most relevant indicator for "resource consumption". Weight only however does not capture the high environmental impact related to products rich in complex electronics such as laptops and smartphones. Indeed, although wider environmental footprint of products tend to increase with their weight, the relation is not linear and impacts may vary substantially across products of similar weight, e.g. depending on the amount of electronic components in them.
- **WG in tons:** strongly correlated to POM (except for rapidly growing or disappearing technologies e.g., LED lamps and CRT screens). Arguably the most relevant indicator for "waste reduction", however as for POM it does not capture the fact that some materials are more impactful than others (e.g., gold versus steel).

High environmental relevance and medium data availability/quality:

- **Carbon footprint of production:** highly relevant environmental indicator, especially to overcome the limitation of the focus on weight only (see above). Is however mathematically much more complex than weight (requires the modelling of complete supply chains and supporting energy mixes), and currently available databases are incomplete and/or too generic.

10 "The Carbon Footprint of WEEE (Waste Electronic and Electrical Equipment) in the UK – a case study based on the UK's largest WEEE producer compliance scheme": https://eprints.lancs.ac.uk/id/eprint/169481/

High environmental relevance and low data availability/quality:

- **Critical raw materials content:** Low data availability, and high variability between models depending on brands and year of manufacture.
- **Problematic substances content:** Low data availability, and high variability between models depending on year of manufacture (due to gradual introduction of substances restrictions and eco-design requirements).
- **Abiotic depletion potential of production:** while relevant, relies on even more data, and less widely accepted mathematical models, than the carbon footprint indicator.
- **Aggregated environmental impact of production (total ReCiPe score):** while relevant, relies on even more data, and less widely accepted mathematical models, than the carbon footprint indicator. Also implies value judgment due to weighting of various impact categories.

Low or medium environmental relevance:

- **POM in units:** low correlation between number of units and resource consumption and waste generation. For example, although LED lamps represent 13% of total units POM, they account for just 0.4% of weight POM, whereas washing machines, which account for just 0.4% of units POM, account for 13% of total weight POM. Units as a metric is less effective a proxy for environmental impact than weight, particularly when the goal is waste prevention.
- **WG in units:** same reason as above.
- **End-of-life carbon footprint:** environmental impacts of end-of-life are negligible in comparison of those generated during production of products[11]. According to our simplified assessment, carbon footprint of end-of-life represents on average 3% of the carbon footprint of production.
- **Collection rate:** collection figures only available at UK category level, which is not granular enough to capture specificities of product types.

Based on these considerations, **POM in tons, WG in tons and Carbon Footprint** are identified as the **most suitable indicators** to prioritise energy-related products for policy intervention to reduce their lifecycle environmental impact, focusing on production and disposal. POM and WG are closely related, so that using both indicators in parallel introduces unnecessary redundancy. If the focus lies on reducing the impacts of production, POM should be used. If it lies on reducing waste generation, both POM and WG can be used (as WG can be considered as "POM with a delay").

2.2 Results

A selection of results from the prioritisation exercise are provided and discussed here, focusing on product types ranking high in relevant indicators. Detailed tables and charts for a wider list of products and indicators can be found in Annex 8.1.

Hereafter, results for selected indicators are given for the top 10 products in terms of waste generated. Besides the above-described indicators "WEEE Generated in tons", "Carbon Footprint production", "CRM score" and "Problematic substances score", additional useful information is provided:

- Whether or not the product type is already subject to eco-design regulations in the UK or EU (specific regulations indicated in the Excel tool);
- Trends in POM and in WG, expressed as compound annual growth rate (CAGR), indicating whether quantities put on the market / generated as waste are increasing, stable or decreasing (over the period 2015-2020).

11 ADEME, 2018. "Modélisation et évaluation des impacts environnementaux de produits de consommation et biens d'équipement"

UNU-KEY (P: Product G: Group)	Description	Existing UK/EU Eco-design Legislation (in blue: including resource efficiency requirements)	POM trend (CAGR 2015-2020)	WEEE Generated 2018 (tons)	WG trend (CAGR 2015-2020)	Carbon Footprint (CF) of production (kilotons CO2-eq)	CRM score	Problem-atic sub-stances score
0104 (P)	Washing Machines (including combined dryers)	yes	2%	161,875	3%	1,326	no data	no data
0108 (P)	Fridges (including combined -fridges)	yes	1%	130,390	3%	1,005	no data	2
0114 (P)	Microwaves (including combined, excl. grills)	no	0%	79,193	3%	489	no data	1
0506 (G)	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	yes	3%	79,012	4%	no data	no data	no data
0202 (G)	Small equip-ment for food preparation (e.g. toaster, grills, food pro-cessing, frying pans)*	no	3%	77,976	3%	1,748	no data	no data
0407 (P)	Cathode Ray Tube TVs	no	0%	67,223	-7%	no data	1	2
0103 (G)	Large cooking equipment (e.g. large furnaces, ovens, cooking equipment)	yes	-1%	64,389	3%	688	no data	no data
0304 (P)	Printers (e.g. scanners, multi functionals, faxes)	no	-2%	62,240	2%	711	no data	1
0105 (P)	Dryers (wash dryers, centri-fuges)	yes	2%	53,917	1%	72	no data	no data
0201 (G)	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)*	yes	0%	50,695	4%	2,126	no data	no data

Table 2: Top 10 product types in terms of WEEE Generated (WG). Products marked with an asterisk: Carbon Footprint data based on closest-match due to missing specific data[12]. Highest results/scores are indicated in red, lowest in green.

12 Data for 0203 used as proxy for 0202; data for 0204 used as proxy for 0201; data for 0001 used as proxy for 0113; data for 0405 used as proxy for 0403.

The same table is provided hereafter, now with the **top 10 products in terms of carbon footprint** (of production).

UNU-KEY (P: Product G: Group)	Description	Existing UK/EU Eco-design Legislation (in blue: including resource efficiency requirements)	POM trend (CAGR 2015-2020)	WEEE Generated 2018 (tons)	WG trend (CAGR 2015-2020)	Carbon Footprint (CF) of production (kilotons CO2-eq)	CRM score	Problem-atic sub-stances score
0309 (P)	Flat Display Panel Monitors (LCD, LED)	yes	-3%	23,820	8%	2,390	1	4
0201 (G)	Other small household equipment (e.g. small venti-lators, irons, clocks, adapt-ers)*	yes	0%	50,695	4%	2,126	no data	no data
0113 (G)	Professional Cooling equip-ment (e.g. large air conditioners, cooling dis-plays)*	yes	-1%	35,209	6%	2,108	no data	2
0408 (P)	Flat Display Panel TVs (LCD, LED, Plasma)	yes	-5%	49,438	7%	1,974	1	4
0303 (P)	Laptops (incl. tablets)	yes	-1%	23,078	-1%	1,899	2	4
0302 (P)	Desktop PCs (excl. monitors, accessories)	yes	-9%	41,574	-2%	1,877	2	4
0202 (G)	Small equip-ment for food preparation (e.g. toaster, grills, food processing, frying pans)*	no	3%	77,976	3%	1,748	no data	no data
0104 (P)	Washing Machines (incl. combined dry-ers)	yes	2%	161,875	3%	1,326	no data	no data
0001 (G)	Central Heating (household installed)	yes	-2%	43,229	3%	1,207	no data	no data
0108 (P)	Fridges (incl. combi-fridges)	yes	1%	130,390	3%	1,005	no data	2

Table 3: Top 10 product types in terms of Carbon Footprint. Products marked with an asterisk: Carbon Footprint data based on closest-match due to missing specific data[13]. Highest results/scores are indicated in red, lowest in green.

13 Data for 0203 used as proxy for 0202; data for 0204 used as proxy for 0201; data for 0001 used as proxy for 0113; data for 0405 used as proxy for 0403.

Many products appear both in the top 10s (WG and CF), indicating the correlation between both indicators (table 4).

UNU-KEY (P: Product G: Group)	Description	Rank in top 10 in terms of WG	Rank in top 10 in terms of CF
0104 (P)	Washing Machines (incl. combined dryers)	1	8
0108 (P)	Fridges (incl. combi-fridges)	2	10
0114 (P)	Microwaves (incl. combined, excl. grills)	3	not in top 10
0506 (G)	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	4	no data
0202 (G)	Small equipment for food preparation (e.g. toaster, grills, food processing, frying pans)*	5	7
0407 (P)	Cathode Ray Tube TVs	6	no data
0103 (G)	Large cooking equipment (e.g. large furnaces, ovens, cooking equipment)*	7	not in top 10
0304 (P)	Printers (e.g. scanners, multi functionals, faxes)	8	not in top 10
0105 (P)	Dryers (wash dryers, centrifuges)	9	not in top 10
0201 (G)	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)*	10	2
0309 (P)	Flat Display Panel Monitors (LCD, LED)	not in top 10	1
0113 (G)	Professional Cooling equipment (e.g. large air conditioners, cooling displays)*	not in top 10	3
0408 (P)	Flat Display Panel TVs (LCD, LED, Plasma)	not in top 10	4
0303 (P)	Laptops (incl. tablets)	not in top 10	5
0302 (P)	Desktop PCs (excl. monitors, accessories)	not in top 10	6
0001 (G)	Central Heating (household installed)	not in top 10	9

Table 4: Products appearing in either or both the top 10 rankings of WEEE Generated and Carbon Footprint (those appearing in both are highlighted in red). Products marked with an asterisk: Carbon Footprint data based on closest-match due to missing specific data[14].

14 Data for 0203 used as proxy for 0202; data for 0204 used as proxy for 0201; data for 0001 used as proxy for 0113; data for 0405 used as proxy for 0403.

Results for the WG and CF indicators are **illustrated in Figure 1**.

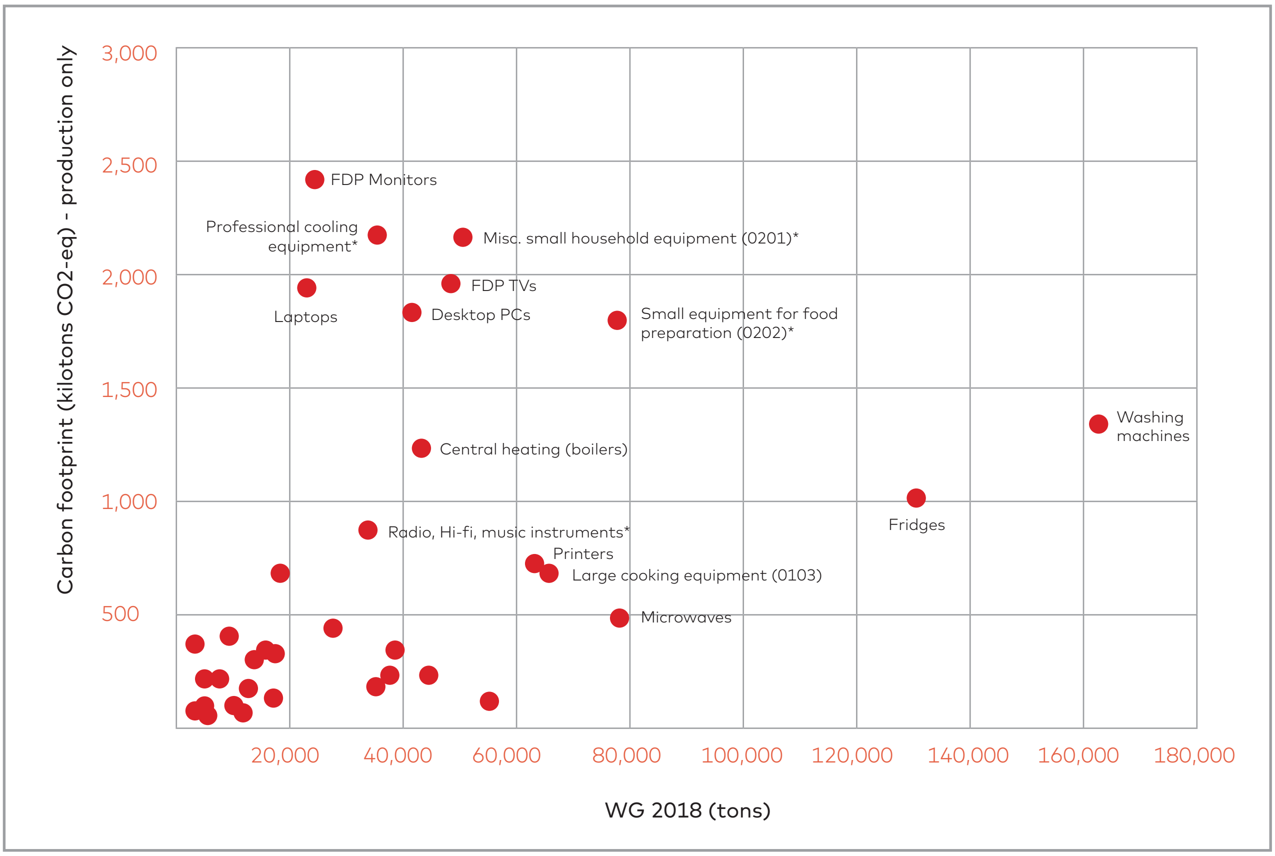


Figure 1: WEEE Generated (WG) and Carbon Footprint (CF) of products for which Life Cycle Analysis (LCA) data is available. Products marked with an asterisk: Carbon Footprint data based on closest-match due to missing specific data[15].

The following **observations** can be made based on these findings:

- **The relationship between WG and CF is not linear:** outlying products that feature highly on the CF axis are mainly ICT equipment such as laptops, monitors and TVs, PCs and small appliances. Outlying products on the WG axis are large domestic appliances such as fridges and washing machines. This is related to the "electronic-richness" of appliances, as electronic components make use of scarce metals which are associated with large environmental impacts during their production. ICT devices are most much "electronically-rich" than large domestic appliances.

15 Data for 0203 used as proxy for 0202; data for 0204 used as proxy for 0201; data for 0001 used as proxy for 0113; data for 0405 used as proxy for 0403.

- An important limitation to the figures and rankings presented above is the **lack of reliable and specific LCA data** (enable the calculation of carbon footprint among other indicators). The ecoinvent database currently includes specific LCA data available for 67% of products in terms of tons POM. A closest-match approach was applied for another 21% of the total, whereby data from another product category was used due to assumed similarities in product composition. For some of the equipment categories ranking high in the CF dimension, such a closest-match approach was necessary:
  - 0113: Professional cooling equipment (proxy 0001: central heating equipment)
  - 0201: Misc. small household equipment (small ventilators, irons, clocks, adapters, etc.) (proxy 0204: vacuum cleaners)
  - 0202: Small equipment for food preparation (toaster, grills, food processing, frying pans, etc.) (proxy 0203: small equipment for hot water preparation)

  The CF score for these product types is therefore highly uncertain, and it is recommended to conduct specific studies to fill in the gaps and provide reliable CF data for those products.
- Contrasting Figure 1 against the **products that do not have any UK or EU eco-design legislation** applied to them, highlights equipment for food preparation (e.g. toaster, grills, food processing, frying pans), microwaves and printers (e.g. scanners, multi functionals, faxes). These represent key potential areas of focus for eco-design policy opportunities.

2.3 Comparison with existing methodologies for prioritisation of products

In preparation for this report, an assessment was conducted of other existing methodologies for the prioritisation of ErPs to be regulated by eco-design requirements, in order to compare any differences to the methodology we have utilised. Specifically, we analysed the European Commission's approach to selecting products to be regulated through implementing measures in the Preparatory Study for the Eco-design and Energy Labelling Working Plan 2020-2024[16]; as well as ICF's UK Energy-related Products Policy Study commissioned by BEIS and Defra[17].

Several key differences emerged between these methodologies and the one implemented in this report for the prioritisation of products. Firstly, in relation to the scope of the studies, **our approach focused exclusively on EEE** (e.g. not including windows, taps and showers, insulation, etc.) while the other two methodologies had a broader scope of assessing all ErPs. Specifically, out of the exhaustive list of 168 energy-related products produced by ICF, 7 are not EEE and therefore excluded from the scope of the current study:

- Printer cartridges
- Glazing products: windows, skylights, greenhouse covers
- Insulation
- Taps and shower heads
- Tyres
- Pipework insulation

16 Preparatory study for the Eco-design and Energy Labelling Working Plan 2020-2024 https://www.eco-designworkingplan20-24.eu/

17 UK Energy-related Products Policy Study (Nov. 2021) https://etl.beis.gov.uk/erp-policy-study

In addition, the methodology instructed for this report focused on the energy consumption of products during the **production and end-of-life stages**, as instructed by Defra. This is a key distinction with the approaches taken by the EU and ICF as, while both do take into account products' impact at all lifecycle stages, these placed a predominant focus and weighting to energy consumption during the **use phase** when shortlisting products to be prioritised.

Another notable distinction between methodologies relates to the market criteria that was applied for the screening of products. Both the EU and ICF focused on product categories' market volume in terms of annual **units POM**, whereas this report focused on annual **weight of ErP POM** as, given the variable weight of different ErP categories, the focus on units rather than weight is considered to be less representative of the actual impact certain products categories have, e.g. 200,000 units of phone chargers vs. 200,000 units of washing machines, while equal in terms of units, diverge substantially in terms of weight (as well as energy and water consumption, and waste generation).

It should also be noted that both of the studies assessed were conducted over longer periods of time, and thus were able to delve into greater levels of detail for all of the products that they screened. Moreover, the two other approaches dedicated a considerable portion of the assessment of product categories to a **regulatory analysis** of any other existing policy measures (particularly at EU-level where a plethora of potentially overlapping measures had to be closely scrutinised to confirm the need for additional eco-design requirements). Further, the EU's approach gave weight when prioritising products not only to their potential for energy savings through further measures but greatly to the **ease/feasibility of implementation** of additional measures for the product category. This all contrasts to our approach which focused more narrowly on assessing quantitative, tangible data related to products' environmental impact.

Building upon this, it should be highlighted that the methodology we have developed is meant to showcase the environmental impact of products according to a variety of criteria, however the relevance of each of these criteria is to be decided by Defra, with the work we have produced acting as a **tool** for making such decisions of prioritisation. This contrasts with the approaches both studies reviewed take, e.g. the EU's study presents a **recommended** shortlist of products for the 2020-24 Working Plan chosen ultimately based on their energy and resource savings potential and/or feasibility of implementation (detailed below).

The following section gives a high-level overview of the approaches followed by both the methodologies reviewed.

2.3.1 EU approach for prioritisation of product groups to be regulated by eco-design implementing measures

The Eco-design Directive 2009/125/EC[18], implemented by the Ecodesign for Energy-Related Products Regulations 2010 in the UK, is a framework directive that establishes EU-wide implementing measures for improving the environmental performance of energy-related products.

The Eco-design Directive applies to all energy related products, and also allows for the creation of additional implementing measures to regulate the eco-design of certain product groups if they meet the following initial criteria (as described in the Directive):

- the product shall represent a significant volume of sales and trade, indicatively **more than 200,000 units** a year within the Community according to the most recently available figures;
- the product shall, considering the quantities placed on the market and/or put into service, **have a significant environmental impact within the Community**;
- the product shall present significant potential for improvement in terms of its environmental impact without entailing excessive costs, taking into account in particular:
  - (i) the absence of other relevant Community legislation or failure of market forces to address the issue properly; and
  - (ii) a wide disparity in the environmental performance of products available on the market with equivalent functionality.

Currently there are over 30 ErP product groups regulated through some 50 implementing measures. The Commission's periodic Working Plans set out lists of product groups to be considered as a priority for implementing measures. In order to set out the product groups in the working plans, the Commission and contracted parties conduct an in-depth preparatory study that dives into addressing the criteria outlined in the Directive, namely the market representation of the product groups, the "environmental impact", and the potential for improvement through additional requirements. The preparatory studies are conducted broadly **following the Methodology for the Eco-design of Energy Related Products (MEErP)**.

The most recent Eco-design and Energy Labelling Working Plan 2022-2024[19] shall guide the Commission's work until the Eco-design for Sustainable Product Regulation comes into implementation (which shall further expand the scope of eco-design requirements as well as the sustainability requirements for the regulated products).

The EU's Communication for the recent working plan emphasised that its selection of "31 most promising product groups for further work" found in the preparatory study represented new **potential use phase savings** in 2030 of "1 000 PJ, or 278 TWh, i.e. ca. 2 % of EU primary energy use in 2020", and that "**priority was given to those products which have the highest potential for energy and/or material efficiency**, and at the same time scored well on other criteria and where stakeholder feedback did not cast significant doubts about the prospects for success," as set out in table 5.

18 Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of eco-design requirements for energy-related products https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009L0125

19 Communication from the Commission Eco-design and Energy Labelling Working Plan 2022-2024 2022/C 182/01 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022XC0504%2801%29&qid=1651649049970

Product group	Energy saving potential 2030 (related to use phase or material efficiency)	Considerations
Low temperature emitters (radiators, convectors)	170 petajoule (P)) (use phase)	Highest energy saving potential, important for Renovation Wavelbuilding decarbonisation
Professional laundry appliances	33 PJ (use phase)	Studied in the past and now considered more mature in view of progress in technical standardisation
Professional dishwashers	20 PJ (use phase)	Studied in the past and now considered more mature in view of progress in technical standardisation
Universal External Power Supplies (EPS)	12-27 PJ (embedded)	Link to Common Charger initiative, will be done as part of review of existing EPS regulation
Electric vehicle chargers	11 PJ (use phase)	After 2030 the potential savings increase, to in 2050 almost 76 PJ annually Hence, it is reasonable to consider setting requirements before large volumes of potentially inefficient chargers are installed

Table 5: Products and their energy saving potential

Indeed, in terms of environmental impact, **the preparatory studies for the EU's working plans** that have been reviewed place particular focus on **energy usage in the use phase of product groups**, and **savings potential for the products, as well as on feasibility/ease of implementation** and at a second stage **increasingly aim to also integrate material efficiency savings questions**.

This is illustrated in Annex 8.2 which gives an overview on the methodology followed in the most recent Preparatory Study for the Eco-design and Energy Labelling Working Plan 2020-2024[20].

It should be highlighted that the MEErP, and thus the process for selection of product groups eligible for further Ecodesign measures, is currently under revision[21] and the results will feed into the further detailing of the implementation of the Ecodesign for Sustainable Products Regulation. A core aim of this revision of the methodology is to further reinforce circularity aspects (such as durability, repairability, identification of chemicals hindering re-use and recycling) in the assessment of products and preparation of eco-design requirements.

Given this objective of a more holistic assessment of products' environmental impact, in this revision, a specific area of analysis is to assess the "relevance of the development of the **Product Environmental Footprint method** (data and approach, e.g. for modelling impacts, normalising and weighting results) and related Product Environmental Footprint Category Rules to the MEErP and the EcoReport tool for assessing lifecycle impacts both for developing the base case and the design options." As such, Task 2 of the revision focuses on the possible inclusion of "changes to the MEErP in order to tackle broader environmental aspects, e.g. using the environmental footprint and/or the ecological profile". The precise way in which PEF will be integrated into the process for Ecodesign measure drafting/ selection of product groups will be clearer once the revision of MEErP is complete, however it is likely to play a greater part in the EU's process of applying Ecodesign measures for products given the role PEF is playing in other initiatives such as on the substantiation of Green Claims[22].

20 https://www.eco-designworkingplan20-24.eu/
21 https://susproc.jrc.ec.europa.eu/product-bureau//product-groups/521/project-plan
22 https://environment.ec.europa.eu/system/files/2022-03/COM_2022_142_1_EN_ACT_part1_v6.pdf
"The upcoming Commission initiative on Green Claims will also complement measures in this legislation, by increasing the reliability, comparability and verifiability of environmental claims about products, via requirements that such claims be substantiated and verified using life cycle analysis methods, including the Product Environmental Footprint method."

2.3.2 ICF's Energy-related Products Policy Study[23]

The work conducted for this study aimed to highlight ErPs with the "greatest environmental impact considering, in particular, their contribution to carbon emissions and resource depletion and the most potential for improving their environmental performance." To achieve this, the study undertook a series of tasks to screen the initial long list of 262 product groups which was first consolidated in task 2 into 184 product groups, based on similarity of components. Task 3 then assessed each product group against 17 evaluation criteria, for which the scoring criteria consisted of:

- **Market:** imports & exports (units/yr); production (units/yr); annual sales (units/yr); market growth (%); existence of energy efficiency measures; price
- **In-use resource consumption:** type of fuel consumption; per unit typical energy consumption; per unit water consumption; per unit consumables use;
- **Circular economy and resource efficiency:** product weight; presence of critical raw materials; product lifetime; duration of guarantee;
- **Technical improvement potential:** energy consumption reduction potential; fuel switching potential; water consumption reduction potential
- **Technical improvement cost:** costs associated with achieving improvements needed to technical improvement potential
- **Combined scores:**
  - **GHG emissions score** (annual sales x per unit energy consumption x type of fuel consumed)
  - **Cost efficiency of reducing energy consumption** (potential to reduce energy consumption x cost to reduce energy consumption).
  - **Potential for life extension** (production price x lifetime x duration of guarantee).
  - **Combined circular economy & market score**

Based on task 3 scores, a shortlist of 26 product groups to focus on in Task 4 in accordance with their potential to **drive energy and carbon savings** was produced. For refining the product groups to shorter list, steps taken included "refining the scope of the product groups by identifying the specific products that would be in scope of the further analysis by focusing on the **20% of specific products in a product group that are responsible for 80% of the energy consumption**". Along with additional analysis of on the energy performance, material composition and circular economy topics related to each of the specific products presented in factsheets.

23 UK Energy-related Products Policy Study (Nov. 2021) https://etl.beis.gov.uk/erp-policy-study

For the assessment of the products, "high level estimates were used to assess the scale of baseline energy consumption and emissions for a single year of product sales" to come to short-listed products with the highest potential for future savings.

We have refrained from delving excessively into detail on the work produced by ICF as Defra is already familiar with the report. However as noted at the beginning of this section, **the key differences between their approach for reaching the shortlist of products and the one we have taken** relate to their focus on energy consumption in the use phase, the assessment of market volumes in terms of units POM, and their more qualitative assessments in relation to regulatory context[24] of each product group to question the need for further initiatives.

24 It should be noted ICF made efforts to align the prioritised products with those put forth in work conducted by EU (as well as assessed any other potential international-level regulations for different product categories).

3 Exploration of lifetime extension potential & implications

When considering potential eco-design measures, the aim is making products better, and thus, inter alia, also to last longer and be more repairable. This in turn reduces impact on the planet in terms of resource consumption. The effectiveness of any measure can be considered against a dual axis of "time to impact" and "magnitude of impact". Consumer behaviour then adds an extra dimension, regardless of how the product is designed to be used or treated at end-of-life.

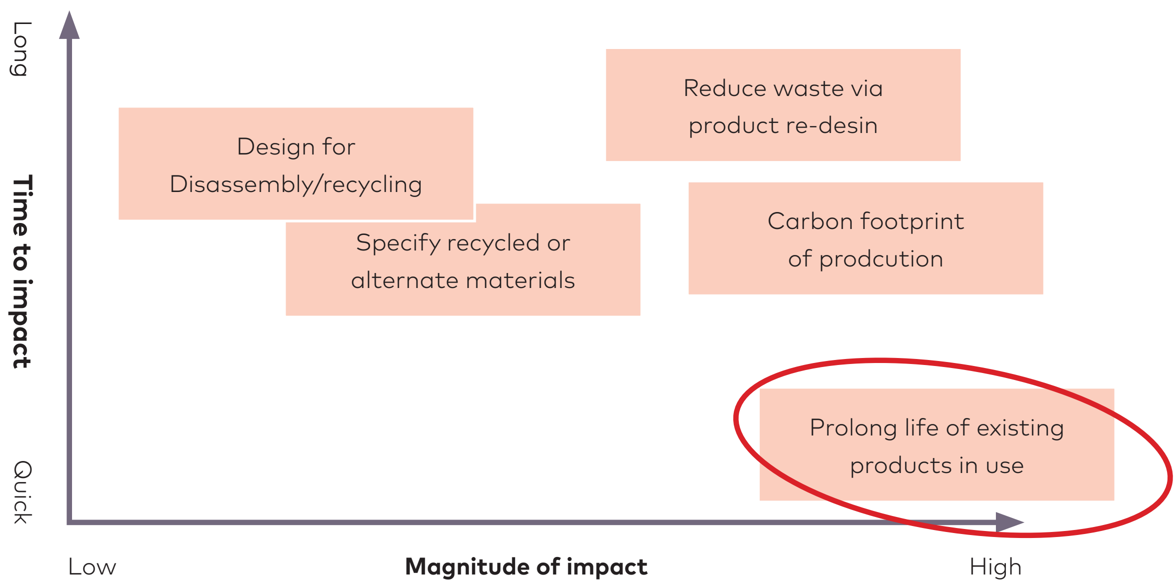


Figure 2: Matrix of time to impact versus magnitude of impact of eco-design measures

As Figure 2 shows, when considering the measures that have high impact but also shorter timescales, extending the life of products comes to the fore.

This chapter therefore considers into the potential and implications of interventions aiming at extending the lifetime of energy-related products.

Firstly, the theoretical impacts of life extension on quantities placed on the market and on WEEE generated are explored, using a model built as part of the study on "*Eco-modulation of producers' financial obligations for WEEE in the UK*" conducted by dss+ for Defra. This provides information on the ability of lifetime extension measures to reduce environmental pressures caused by products' manufacture and waste management.

Subsequently, three specific types of lifetime extension measures are investigated:

- Provisions on availability of spare parts
- Extended duration of standard guarantees
- Use of eco-labels such as the Repairability Index

The provision of spare parts is currently used on a number of ErP categories so the impact of this on lifetime extension was chosen for closer investigation. The provision of a longer standard producer guarantee was included because guarantees can be considered as a proxy for better product (i.e. products that are more robust or better designed should be less faulty and hence producers might be willing to offer longer guarantees to customers). The role of eco-labelling was explored because it is known that producers are largely in favour of measures such as labels that can give them a competitive advantage when consumers are comparing products at the buying decision stage. In particular, the Repairability Index introduced in France is discussed because of its novelty and its good reception by consumers and producers. This is explored further in section 3.2.3.

3.1 Simulation of lifetime extension impacts on POM and WG

Here, results from an **analysis on impacts of lifetime extension on quantities of product placed on the market as well as WEEE generated** are presented. This analysis was initially conducted as part of the study on "*Eco-modulation of producers' financial obligations for WEEE in the UK*" conducted by dss+ for Defra.

The analysis is based on a mathematical model that links quantities put on the market (POM), lifetime distributions (obsolescence rates, expressed as Weibull distribution) and WEEE generated (WG). It applies the "**Waste over Time**" methodology[25], which reflects EU's "**common methodology**" to calculate POM and WG[26]. The model built here allows to run various scenarios using different lifetime distributions for specific products.

The following **simplifying assumptions** were made for the modelling:

- Products with an extended life have an **average lifespan 50% longer** than conventional, business-as-usual products.
- Products with an extended lifetime were introduced on the market in 2010, with a **20% market share** that stays constant over the years. Simulating such an early market entry is due to the delayed effects caused by the relatively long lifetime of most electrical and electronic appliances. Sufficient time is needed for changes in POM to have a notable effect of WEEE Generated. If products with an extended lifetime were introduced on the market today, the impact on waste generation would only be visible after 5-20 years depending on the type of product.
- **Sales after 2018 remain at a constant level**, both for baseline products and products with a 50% life extension, to exclude any effects due to POM variations and isolate those related to lifetime extension.
- The **stock remains constant over time**, meaning that there is no increase in the installation rate (e.g., number of fridges per household). As a longer lifespan with the same POM values would lead to an increase of stock, POM is adjusted in the model (downwards) to ensure that the stock stays constant.

This approach is **illustrated** below for the case of washing machines: figure 3 below shows the lifetime profiles for baseline products and products with an extended lifetime; it shows the impact on WEEE generated (WG) for the period 2010-2030. It can be observed that the arrival on the market of extended lifetime products in 2010 (with a 20% market share) **does not have an immediate impact** on the quantities of waste produced. The impact only becomes really significant 5-6 years after the product is put on the market. Overall, the **reduction in waste over the period 2020-2030 is forecasted at 12%**.

25 https://github.com/Statistics-Netherlands/ewaste

26 Commission Implementing Regulation (EU) 2017/699 of 18 April 2017 establishing a common methodology for the calculation of the weight of electrical and electronic equipment (EEE) placed on the market of each Member State and a common methodology for the calculation of the quantity of waste electrical and electronic equipment (WEEE) generated by weight in each Member State

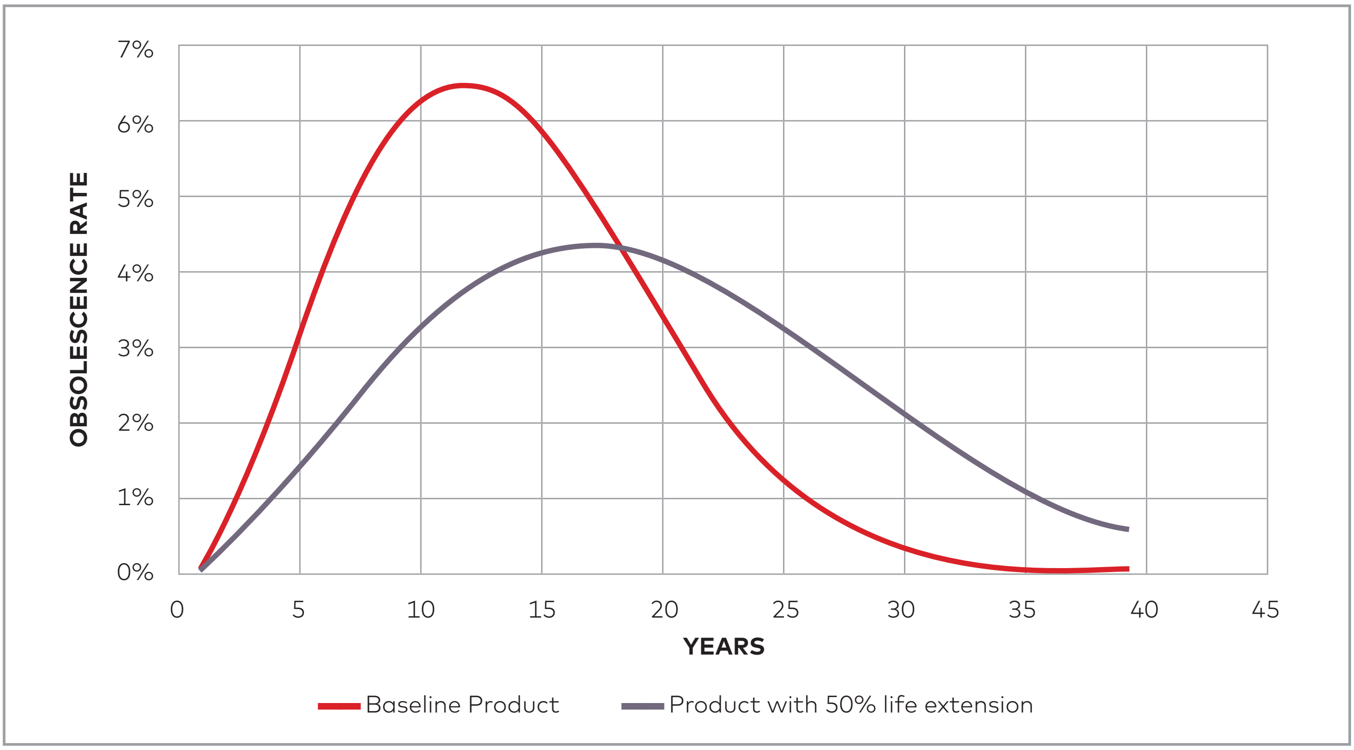


Figure 3: Weibull function for washing machines (baseline vs longer lifespan)

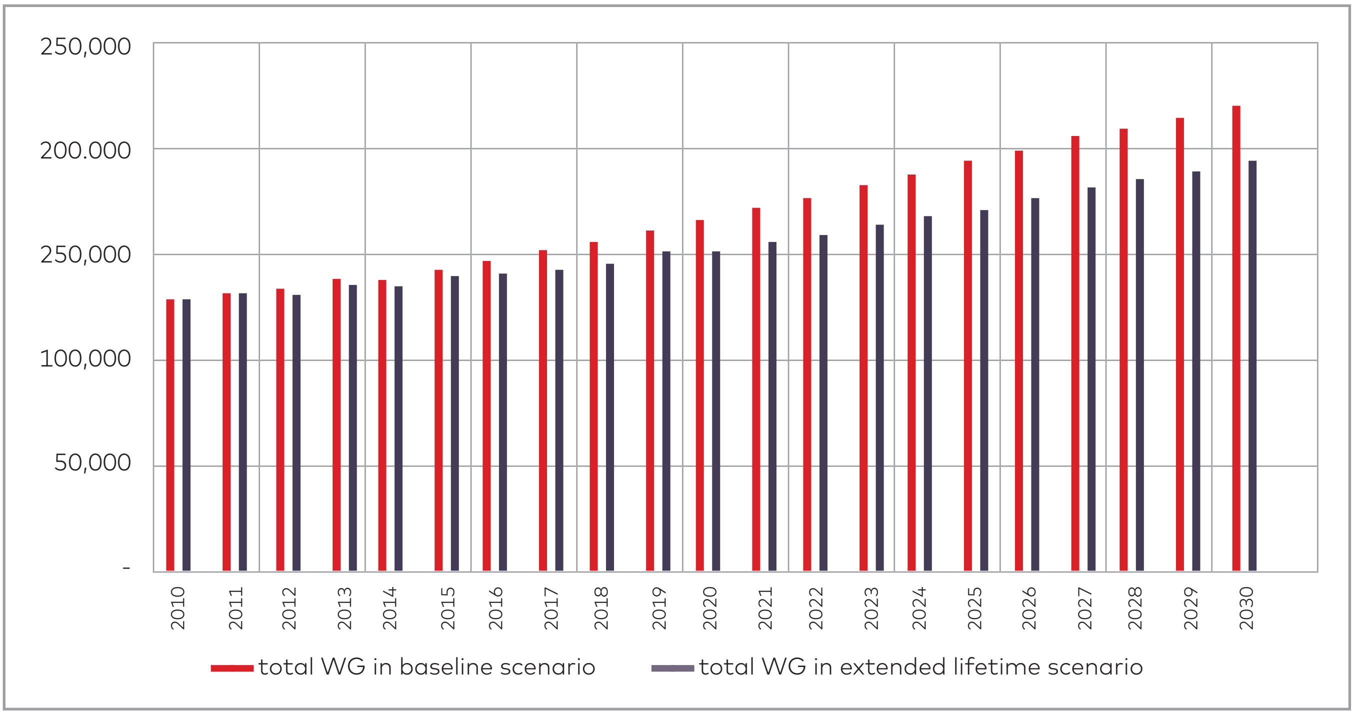


Figure 4: Reduction of waste generated linked to 20% of products having 50% longer lifespan, example for washing machines

Results for 17 types of products (representing more than 80% of total POM) are given in table 6. Impacts on POM and WG were calculated, in kilotons and in percent. Overall, the simulated scenario (20% market share for products with a 50% longer lifetime) results in a **10% diminution in POM over the period 2020-2030, and a 6% reduction in WG over the same period**.

The impact on both POM and WG varies among products, which has to do with the evolution of POM up until 2018 (increasing, constant or decreasing) as well as whether products are rather long- or short-lived. The product type with the highest decrease in WG, flat display TVs, has witnessed a drastic increase in POM between 2010 and 2018 (+500%) and have a baseline average lifetime of 10.4 years. In contrast, freezers, for which impact on WG is the smallest, have witnessed a modest increase in POM (+26% over 2010-2018) and have a baseline average lifetime of 21.5 years. In conclusion, **impacts of lifetime extensions are highest for products with a rapidly increasing market share and relatively shorter lifetimes, and lowest for products with stable POM and long-baseline lifetimes**. Policy interventions aimed at extending lifetimes to reduce environmental impacts related to POM and WG should therefore target priority products belonging to the first category.

Equipment	Impact on POM 2020-2030		Impact on WG 2020-2030	
	in kilotons	in percent	in kilotons	in percent
Central Heating	44.4	-6%	-67.4	-11%
Dish washers	29.8	-6%	-44.7	-8%
Washing Machines	163.5	-6%	-234.8	-11%
Dryers	15.7	-11%	-36.9	-8%
Fridges	117.7	-5%	-176.8	-9%
Freezers	8.7	-2%	-16.2	-3%
Air Conditioners	9.8	-7%	-15.7	-10%
Microwaves	37.7	-4%	-56.0	-6%
Vacuum Cleaners	41.4	-7%	-53.0	-10%
Desktop PCs	25.3	-10%	-37.9	-11%
Laptops (incl. tablets)	22.0	-10%	-25.4	-11%
Printers	24.3	-4%	-34.9	-5%
Mobile Phones	2.8	-11%	-3.2	-11%
Flat Display Panel Monitors	7.7	-3%	-10.6	-4%
Video	21.6	-8%	-29.2	-10%
Speakers	16.8	-7%	-22.2	-10%
Flat Display Panel TVs	44.1	-9%	-73.5	-12%
Total	**-633.4**	**-10%**	**-938.4**	**-6%**

Table 6: Simulated impact of lifetime extension on quantities placed on the UK market (POM) and WEEE generated (WG)

While the potential POM and WG reductions are significant, they may be less than expected considering that products with an extended lifetime make up 20% of the total sales. This is due to two main factors:

- It takes a long time for changes in lifetime of new products to have their full impacts on waste generated, due to the relatively long lifetimes of ErPs (both in-use and in hibernation). ErPs typically have a Weibull lifetime distribution, characterized by a relatively long tail, meaning that a significant fraction of the products will have a lifetime considerably longer than the average for those products.
- Extending lifetimes only delays the time of waste arising, but waste still eventually arises. Assuming a hypothetical scenario where stock is constant over a long period of time, extending the lifetime of products wouldn't reduce POM nor WG.

It is also important to note that **even if products were designed to last longer**, the **role that consumers play** in the effective lifetime of products lies often **beyond the control of producers**. Various studies conducted in the last decade indeed highlighted that a **high share of products discarded were not so due to technical failure**, but rather because consumers wished to acquire a new one.

3.2 Investigation of lifetime extension measures

An in-depth investigation of all possible lifetime extension measure was not possible in the timescales available. With the most recent EU and UK legislative **measures focussing on ensuring the availability of spare parts to encourage repairability**, how this was viewed and implemented by industry was first investigated. This in turn led to the **exploration of the impact of much longer guarantees as standard and in turn the role of eco-labelling**.

3.2.1 Availability of spare parts

The industry has developed over time repair programs (in Home Appliance Industry the turnover connected to repair activities can be as high as 8%) managed directly or through a network of repair centres. Surveys conducted by the project team with APPLiA Members revealed that for the Home Appliance Industry 91% of the requests for repair have been fulfilled (through a network of more than 29,000 business partners). **The cost of maintaining at stock spare parts represents on average 29% to 44% of the total repair cost**. In addition, research conducted in March 2022 for WEEE Ireland into the repairability of White Goods found that **95% of the repairs requested in 2020 (both in and out of warrantee) were repaired** with only 5% resulting in a replacement[27]. This demonstrates that for this product category, mandating an increase in spare parts will simply result in an increase of the cost of repair (that is passed on to consumers) and not encourage a greater rate of repair, which is already considerably high. One caveat to note however, is that this statistic only accounts for the products where the consumer asks for a repair. There are likely to be many instances where a product can be repaired but consumers do not act upon this.

In order to understand the financial, practical and resource impact that keeping spare parts available entails, **a number of stakeholder discussions were held**. These took the form of one-to-one informal conversations with producers that varied from large domestic appliances to IT products. Some high-level data was also shared where possible and used to quantify claims where possible. From these discussions, a number of observations can be made about **the impact of spare part availability on extending product lifetime**, although it is acknowledged these are only indicative, due to the limited number of producers interviewed:

27 https://www.ibec.ie/-/media/documents/connect-and-learn/industries/technology-and-telecoms/white-goods-association/wga-repair-data-survey.pdf

Cost impact of spare part availability

The cost of producing, selling, storing and maintaining an up-to-date provision of spare parts is a significant undertaking for all those interviewed, with quotes ranging from £1.4m for UK warehousing and employment of 18 full time staff alone through to £2 million globally for another producer. The **physical holding of spares is seen as essential** to enabling engineers to have parts available quickly to repair problems as they arise, especially when consumers are often not willing to wait longer than a few days for repairs. In practice, for one large domestic appliance producer to fulfil warrantee commitments, **this means holding some 217,600 spare parts across 54,200 different part types (SKUs)** which averages 4 parts per SKU.

Another appliance producer holds a lesser amount of **approx. 60,000 parts across 6,300 SKU**, an average of 9 parts per SKU. However, in reality, the number of parts held for different SKUs is closely monitored via regular stock taking to reflect the frequency at which certain parts are needed. 26,000 SKUs only have 1 part held whilst some frequently needed parts might have over 7,000 in stock. Such frequently needed parts are commonly those that are used heavily by the consumer such as control knobs, springs for switches and doors seals/catches. This **consumer-centric spare parts provision** is mirrored in the numbers quoted by one producer of the numbers held by their third-party service that provides parts directly to consumers or independent engineers which hold a far greater number of parts at some **600,000 parts over just 8,200 SKUs**.

The percentage of spare parts ordered and then used was found to be high – for one producer, it was at 98% as shown below.

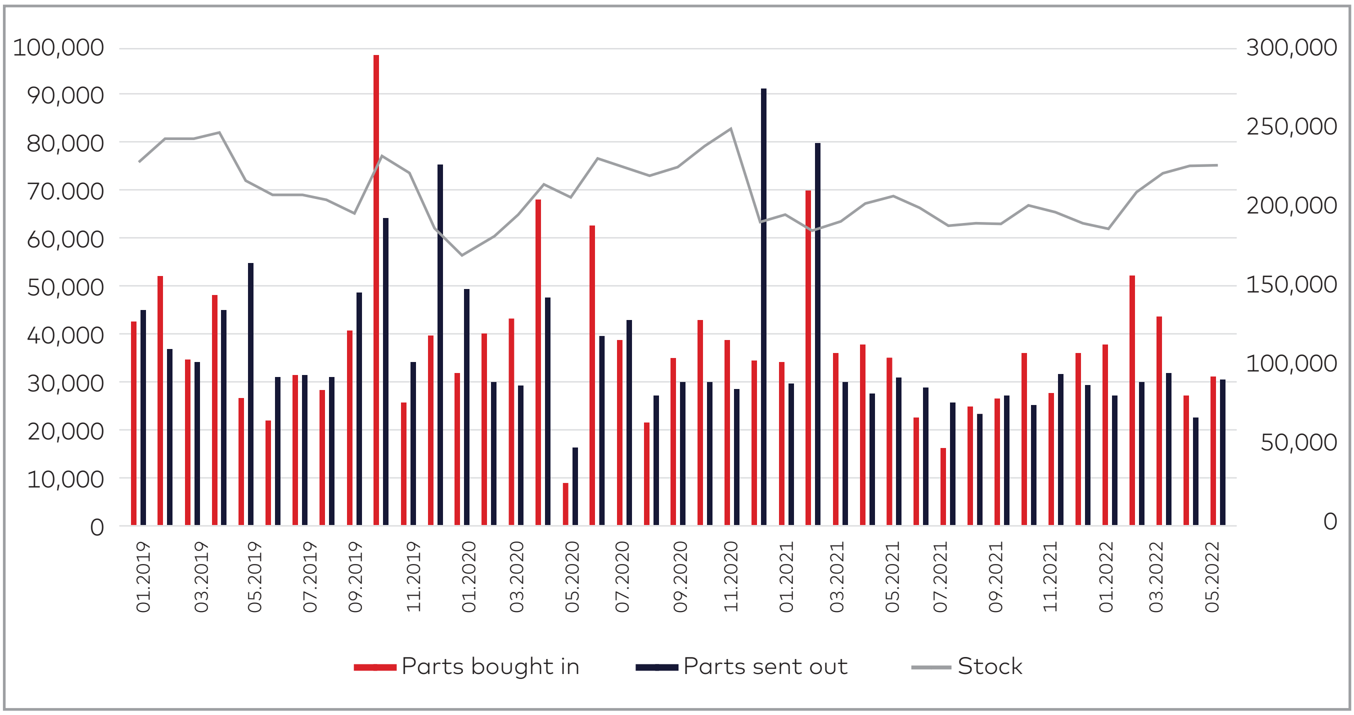


Figure 5: Evolution of incoming, outgoing and in-stock parts (UK data from a leading domestic appliances producer)

Stock is carefully managed with **some companies physically holding the parts they need** – to offer reliability of availability to their engineers – especially as the parts in question are all made overseas in countries such as China or Turkey.

Others do not physically hold the parts but know they can get the parts if needed. **The acceptable timescale for a repair can also widely vary** – 2 weeks to repair a laptop might be acceptable but for an item such as a washing machine, it needs to be addressed within the timeframe of a few days or else a consumer could potentially prefer to buy a new item instead. The cost of holding and sourcing parts reflects this connection with consumer expectations of a brand's products. All the producers interviewed considered **the consumer experience as critical** – even doing a repair at cost to them if necessary. This is further explored in Section 5.

Holding spare parts is the norm – to fulfil brand expectations

Providing spare parts is seen by all producers interviewed as **a necessary service from a product quality point of view as well as from that of brand perception**. The standard guarantees offered anticipates that basic parts such as buttons, switches, handles and dials will break, especially as they are main contact points with the consumer. Other parts have a set technological lifespan, after which they lose their efficacy such as the optimum performance of a laptop battery being around 3 years. **Extended warrantees are therefore calculated to allow for the failure of the most common parts** - giving the consumer both reassurance of the quality of their purchase but also a continued relationship with the manufacturer and a means of additional income.

Cost of a repair

The cost of parts versus the cost of engineering time and price paid for the product is another key theme that arose from the discussions. Data shared by one producer gave the average cost for a repair to be viable to a consumer (versus buying new) for large domestic appliances at just £140 – including parts, labour and VAT. The parts themselves are low cost (75% of parts under guarantee are sold at a price of £0.50 - £12.50) but additional costs of the engineer's time and VAT, means that, especially **for market entry products, if the product is not under guarantee or extended warranty, there is no economic viability of fixing** a product versus buying a new one. The percentage of a repair that is made up of part, labour and transport is illustrated in data gained from research conducted with APPLiA:

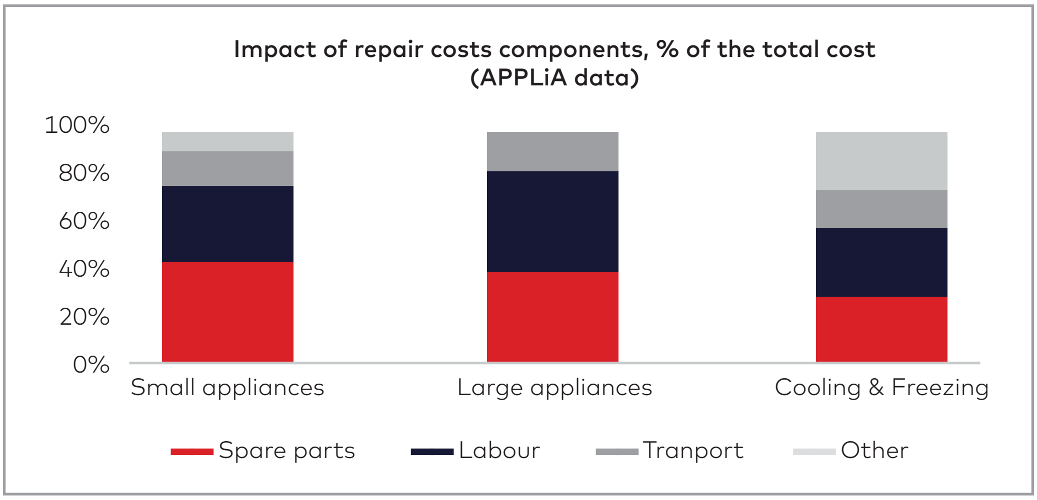


Figure 6: Impact of repair costs components, % of the total cost (source: APPLiA data)

There is significant interconnectivity between the producer and the repair engineers, the spare parts industry and the independent repairers who reply on the availability of spare parts to offer that service (only 40% of out-of-warranty repairs are done by the producer). Therein, there would be a ripple effect of any policies introduced.

Given the impact that a guarantee or extended warranty being in place have in ensuring the path of repair is chosen, rather than replacement for a new product, one idea considered to encourage resource efficiency of ErP products through repair was to **make all standard guarantees to be 7 or 10 years rather than 1 or 2 years**.

Interviewees gave a number of reasons why this option was not considered to be viable in Section 3.2.2

Time parts are held for

The time that parts are held in stock is not pre-determined (unless specified in existing Ecodesign regulations). It is currently decided based on the length of maintenance contracts and extended warrantee periods offered (typically being 4-5 years). Some parts also have a shelf-life after which their performance will be impacted, such as a motor or laptop batteries which tends to be 3 years after which their capacity starts to diminish.

The end-of-life fate of spare parts also differs – for one large domestic appliance producer, they are destroyed at a cost to the company (one estimation was £60,000 a year for the destruction of 32,000 parts) whereas for an IT producer, a long extended market via online global platforms offers 2nd, 3rd and 4th lives for these spare parts – thus being a revenue stream and not a resource sink.

In conclusion, encouraging repairability through mandatory availability of spare parts for product categories such as large domestic appliances and laptops where there already is an established, independent repair industry is unlikely to increase the number of products remaining in use in those categories. **The regulatory requirement for spare part availability should not be applied as a default but instead be assessed per product category with consideration given to factors including maturity of the category, level of anticipated impact on life extension and environmental impact of making spare parts**.

Case study: classification of transit bolts

One case study to demonstrate how UK regulation could extend the lifetime of a product is that of **transit bolts for washing machines**. These bolts are provided by the producer to hold the drum in place during transit. Once the machine has been installed, the transit bolt is often lost or mislaid. When a machine then needs to be moved for repair, refurbishment or relocation, without these transit bolts to re-attach, the drum can cause internal damage to the washing machine.

Using statistics shared by a UK washing machine recycler/refurbisher, if 2.85 million washing machines are sold annually in the UK (assuming a lifetime of 7 years), 320,000 (11.2%) of these are technically suitable for reuse. However, **24,000 (7.5%) of these washing machines incur damage** to the circuit boards caused by impact with the unsecured washing machine drum. Data shared by the largest White Goods Reuse Operator in the UK estimated the magnitude of impact that for every 1,000,000 washing machines sent for recycling in the UK **an additional 8,510 could be repaired if the transit bolts had prevented internal damage**. Without these bolts, refurbished machines are also at risk of damage when moved to a resale location or to the end users' home – 8.3% of the company's refurbished products are lost in this way. This equates to an additional 13,280 machines not being returned to their use phase.

The challenge is two-fold in that transit bolts differ by manufacturer and appliance and therefore there is no easy way in the reuse operation to identify and install replacement bolts that are lost. Secondly, the EA has classified these bolts as waste packaging which means their weight has to be declared and paid for under the Waste Packaging obligations rather than being seen as an integral part of the machine.

Recommendation: There may be an opportunity to set a requirement using Ecodesign that the transit bolt is permanently attached to the machine. A large producer interviewed indicated they would be unlikely to incur the cost to redesign their transit bolts unless compelled to do so by regulations.

3.2.2 Longer standard guarantees

One outcome from the discussion on spare part availability was that products under standard guarantee were more readily repaired by consumers as it is a free service and seen as an easy option. Extended warranties are offered as a paid-for extra so **one potential recommendation could be for a standard guarantee to be extended to 7 or 8 years in order to encourage consumers to view products as being worth repairing** over a longer period of time. The period of 7 or 8 years was chosen as an average of the 5- and 10-year extended warrantees typically available to buy. We sought the feedback of a small number of producers on this.

A standard guarantee being 7 or 8 years rather than 1 or 2 is **generally not supported by those from industry interviewed on economic, social and practical grounds**. Those interviewed demonstrated that offering a longer guarantee would incur **increased product costs on average of 12%** to allow for the costs of parts (plus engineer repair and diagnostic time) that would need to be replaced over that extended time period. Many parts for products such as large domestic appliances, have a natural physical lifespan of 2-3 years and so it is known that these will certainly need to be replaced multiple times during the guarantee period at a cost to the company. Whilst one IT producer suggested 5 years was the maximum they could consider offering, they also cited their experience of their extended warranty sales in Finland dropping to almost zero in response to Finland's requirement for a standard 5-year guarantee. They are therefore concerned that a similar trend would happen in the UK, creating a loss of revenue.

Large domestic appliances are a very price sensitive market and this additional cost is likely to be prohibitive to the customer and impact negatively on producers. **Selling extended warranties is also a revenue stream for companies** and the loss of this income would need to be recouped back via the cost price to consumers. One IT producer estimated **a potential loss of UK market income as being in the region of £9.5million** loss for basic repairs, premium support repairs and out of warranty repairs combined.

All those interviewed also expressed concern of the social impact on the independent repair market that exists. Demand for independent repairs for out-of-guarantee products would decline significantly, potentially putting such individuals out of business. Repair engineers are paid a lower rate for guarantee and warranty repairs (£50 versus £70) as producers achieve cost efficiencies by having engineers working on free repairs rather than doing nothing. So **a longer mandatory minimum guarantee period could negatively impact the repair sector** by reducing the margin on the work and the number of independent repairers available.

An additional consideration are **cosmetic repairs of the product** – the colour of a fridge door or laptop cover will fade over time so will be impossible to match to the rest of the product if replaced. This could potentially create additional material waste if more of the product has to be replaced to maintain product appearance.

For the limited sample of producers of large domestic appliance and IT products interviewed, this is not a feasible policy approach to encourage repair of products as the cost to industry and end consumer would not justify the benefit to increased number of products being repaired. But it is noted that those interviewed are from product categories that are "open" (this refers to products with an established independent repair market where spare parts are widely available and consumers have a choice of where to get the product repaired). **Longer guarantees as standard might be feasible for "closed" categories of products** (i.e. categories where repair is currently not so prevalent due to low value of the product or the lack of infrastructure of parts and independent engineers as only the producer can offer repairs).

3.2.3 Eco-labels: the case of the Repairability Index

The Repairability Index was rolled out in France on January 1, 2021 on five product categories: smartphones, laptops, televisions, lawnmowers and porthole washing machines. From November 4, 2022, four new product categories will be concerned (top washing machines, dishwashers, vacuum cleaners, high pressure cleaners). This tool, provided for in the anti-waste law for a circular economy *(Loi anti-gaspillage pour une économie circulaire)*, **aims to better inform consumers about the more or less repairable nature of their purchases**. The law makes the display of the Index mandatory for the concerned product categories.

This information **makes consumers aware of the possibility of extending the lifetime of their appliances**, in particular by directing their purchasing behaviour towards products that are more easily repairable and by encouraging them to make greater use of repairs in the event of breakdown. It is conceived as a tool to fight against obsolescence to avoid the early disposal of products and preserve the natural resources necessary for their production. By 2024, the anti-waste law for a circular economy plans for this Index to become a Sustainability Index (indice de durabilité), including the addition of new criteria such as robustness or reliability of products.

The calculation of the Repairability Index for each product model is based on **five criteria**:

- **Documentation:** score determined by the producer's commitment to make technical documents available free of charge, in number of years, to repairers and consumers.
- **Removability and access, tools, fasteners:** score determined by the ease of disassembly of the product, the type of tools required and the characteristics of the fasteners.
- **Availability of spare parts:** Score determined by the producer's engagement on the duration of availability of spare parts and on the delay of their delivery.
- **Price of spare parts:** score determined by the ratio between the selling price of the spare parts and the price of the product.
- **Specific:** score determined by sub-criteria specific to the product category concerned.

The Repairability Index results from the calculation of these scores by criteria, reduced to a **score out of 10**. The details of the scoring must be made available to the consumer by the seller at the time of purchase and, if not the same, by the manufacturer on request, for each model concerned. The scoring method is illustrated in the following figure, taking the scoring sheet published by Apple for its iPhone 12 as an example.

Criteria	Sub-criteria	Score of Subcriterion/10	Weighting factor of subcriterion	Score of criterion /20	Total Criteria scores /100
CRITERION 1: DOCUMENTATION	1.1 Availability of the technical documentation and other documentation related to user and maintenance instructions	6.2	2	12.3	59.6
CRITERION 2: DISASSEMBLY, ACCESSIBILITY, TOOL, FASTENERS	2.1 Ease of disassembly parts from List 2*	2.6	1	5.9	
	2.2 Necessary tools (List 2)	1.9	0.5		
	2.3 Fasteners characteristics parts from List 1** and List 2	5.0	0.5		
CRITERION 3: AVAILABILITY OF SPARE PARTS	3.1 Availability over time parts from List 2	6.6	1	9.3	
	3.2 Availability over time parts from List 1	1.3	0.5		
	3.3 Delivery time parts from List 2	6.6	0.3		
	3.4 Delivery time parts from List 1	1.3	0.2		
CRITERION 4: PRICE OF SPARE PARTS	4.0 Ratio between price of parts from list 2 to the price of the product	6.0	2	12.0	
CRITERION 5: SPECIFIC CRITERION	5.1 Accessibilty of usage-counter to consumers	10.0	1	20.0	
	5.2 Free remote assistance	10.0	0.5		
	5.3 Possibility to reset softwares	10.0	0.5		
				Repairability Index on 10	**6**

Figure 7: Apple's score sheet for the iPhone 12 in the French Repairability Index (*source: ifixit.com*)

All published scores are **centrally available** on the web platform "indicereparabilite.fr", and also integrated in the widely used products comparison platform "Les Numériques"[28], similar to "Which?" in the UK. This gives the possibility to use the repairability score as filter when searching for products.

28 https://www.lesnumeriques.com/telephone-portable/comparatif-smartphones-telephones-portables-a407.html

Here are some key insights into the **success and limitations** of the Index 1.5 years after its introduction:

- From a **consumer perspective**, the Index was reviewed by the consumer associations HOP[29] and UFC[30], with the following findings:
  - » Good customers reception: 55% of consumers surveyed have heard about it, and 76% of consumer who bought a product subject to this Index declared the information was useful and helped them make a choice.
  - » Need for harmonisation: large differences between product categories in visibility of the Index (e.g., more visible for smartphones than laptops).
  - » Need for third-party checks: scores calculated by producers themselves (as for the energy label). HOP selected 6 products and did the calculations, found that for 5 products the score was overrated by about 15% (mainly related to spare parts availability).
  - » The way in which the calculation is made means that very few products have low scores, e.g. lawnmowers and washing machines often have very high scores. The Index could be made stricter to provide more incentive for producers to improve design (e.g. by giving more weight to dismantlability, availability or price of spare parts).
  - » Some products may get a green label, supposed to indicate good repairability, when in reality it may be easy to disassemble however the lack or high cost of spare parts may lead to a replacement with a new device.
  - » Overall it is quite a good tool however some improvements possible: those mentioned above as well as awareness raising campaigns and disclosing scoring grids to provide full picture to consumers.
- From a **producer perspective**, based on insights provided by stakeholders interviewed as part of the Eco-modulation study as well as the current one, the Repairability Index was often cited as an effective tool to foster change in the design of the products. This initiative had triggered swift design changes to get better index scores. Investing time to redesign products to gain even a small incremental increase (such as from 7.7 to 8.2) gives them advantage in other markets other than just in France. Getting the Repairability Index of their products higher is considered a priority because it is a visible, consumer-facing feature that can influence consumer's buying decision and is a non-economic competitive advantage. Regarding incentives for change, a producer stated that consumer labelling "is more powerful than money".

In summary, the Repairability Index seems to be a promising tool to incentivise the design of more repairable and therefore longer-lasting products. It is well received by both consumers and producers and has the potential to be used along with energy efficiency labels as a simple, visible, purchasing guidance for consumers. There are however a few **risks** to note:

- **High repairability score does not mean that the product will be repaired nor that it will have a longer lifetime.** Consumer behaviour and desires, technological developments and repair economics, may well lead to the discard of functional appliances or dysfunctional ones where a repair would be cost-effective (in comparison with the purchase of a new one).
- **Harmonisation is essential, between product categories and between national markets.** Lack of harmonisation will greatly reduce the acceptability of these indices to producers and thus jeopardise their existence. Scoring and displaying methods should ideally be the same across countries, at least at the European level.
- **Third-party controls are required** to ensure credibility of the scheme, checking that scorings are done objectively and in a harmonised manner.

29 https://www.halteobsolescence.org/lindice-de-reparabilite-tient-il-ses-promesses/

30 https://www.quechoisir.org/action-ufc-que-choisir-indice-de-reparabilite-le-consommateur-bien-mal-eclaire-n96968/

4 Additional priority products

In conjunction to the prioritisation list created for this report, it is important to acknowledge the ongoing work of BEIS to identify products in need of regulatory support. The priority list created by BEIS looks at ErP products using levels of energy during its use phrase as a core criterion. In aligning our work with that of BEIS, **an additional two products were highlighted as priority in the UK: domestic cookers and space heaters (which includes conventional gas boilers, hydrogen-ready boilers and hybrid boiler and heat pump systems)**.

In the prioritisation metrics described in chapter 2, domestic cooking and space heating equipment correspond respectively to the categories "0103: Large cooking equipment" and "0001: Central Heating". As seen in Figure 1 (page 23), both rank mediumly in the CF and WG dimensions. Below, the exact ranking of both types of products is given.

UNU-KEY	Description	Rank in top 10 in terms of WG	Rank in top 10 in terms of CF
0103	Large cooking equipment (e.g. large furnaces, ovens, cooking equipment)	7	not in top 10
0001	Central Heating (household installed)	not in top 10	9

To capitalise on our engagement conversations on resource efficiency with stakeholders, these two product categories were included to understand stakeholders' views of potential regulatory options. Spare part availability has been one key requirement applied to other product categories such as washing machines and fridges whereby this was one of the questions posed. The following observations were made:

4.1 Domestic cooking

There is a well-established spare parts industry for domestic cookers – thus mandatory spare parts are unlikely to improve existing life-extension, beyond standardising existing best practice. Domestic cookers are simple products with fewer complex parts that are at risk of failing or being costly to fix. **Domestic cookers have a low price point**, as reflected in the quality of their components and materials. Sturdier machines would better withstand being moved and handled but this will impact on the quality of materials used and thus on the price point to consumers.

Far more impactful, was the suggestion to **refurbish cookers to retain the use of products via a secondary market** or to remanufacture to allow the use of large parts that do not fail such as the outer body of a cooker. Some producers expressed the desire for an infrastructure to strip down and remake cookers, as opposed to recycling. Current barriers to this are the inability to return machines to overseas manufacturers for refurbishment and with appliance transport mainly being outsourced to a third party, it is not commercially viable to collect old or faulty appliances for refurbishment. In addition, many retailers offer a "28 day no quibble guarantee" which enables consumers to return products and get a replacement without any in-depth investigation as to the reason for return (be it technical failure, personal choice, cosmetic issues or something else).

Whilst product returns can be resold, these seconds carry the "open box stigma" or negative image of not being brand new, even though possibly having no fault. The lack of assessment as to the reason for return can devalue products unnecessarily and yet testing to verify the cause of a return is a cost that the retailer cannot absorb. One producer expressed a desire to instigate a process of fault verification but was concerned the retailer might replace them with an alternative supplier. Based on the views expressed by the producers interviewed, **there is an opportunity for UK legislation to encourage the creation of a take-back and refurbishment sector for domestic cookers to keep resources in use for longer**.

4.2 Space heaters

In discussions with seven companies within the space heater industry, the suggestion of a spare part requirement for the sector was widely agreed with and accepted – mainly because the sector already offers spare parts for an average of 10-12 years already. This is either just standard practice of producers or are basic requirements by membership organisations such as HHIC or to supply companies such as British Gas. A widely supported suggestion was also that instead of introducing blanket 10-year spare part requirements, **non-functional parts could have a shorter period such as 7 years and key functioning parts be 10-15 years**.

Formalising spare part availability into UK regulation would therefore not hugely impact producers' current ways of work but **would provide certainty and transparency with regard to the availability of spares for a fixed period of time**, wherein both repair engineers and consumers would know the likelihood of ability to fix faults. This highlighted a key theme across many discussions: **the role of the repair engineer** in the resource efficiency of space heaters. They are the key point of contact providing expert advice to consumers as to the cost effectiveness and feasibility of repair or, if necessary, the type and specification of a replacement boiler. A number of trends were reported:

- Instances were reported where engineers had advised customers to replace rather than repair faulty equipment, **in some cases citing the availability or reliability of spare parts as a factor**.
- **Engineers need to be furnished with all the information of new technologies to best advise the customer**. One aspect highlighted here was that the "system label" data is not widely used and this can have a large impact on the efficacy and long-term cost of a boiler. A system label energy rating factors in not just the boiler specification but also the type of controls used (be it a basic thermostat or a Wi-Fi enabled system that links to external temperatures and so is more responsive). A system label therefore offers a different and more realistic energy rating as it considers how the boiler will be used and controlled rather than just the boiler as a piece of equipment. One outcome would be **the enforced use of such system data** to give a fuller picture of how the space heater will function in reality.
- There is an overall belief that **existing gas boilers have reached their maximum in mechanical energy efficiency** and that the influencing factors now are the controls that enable them to be used in a way that responds to the weather, user habits or external influences. To do this requires the use of more innovative electronics and PCB components which consequently can be the part of a space heater that will more easily break or be costly to replace than a simple mechanical valve or heating component.

Another key aspect of repairability that this sector in particular faces is that of **safety**. Whilst one producer suggested that some simpler, non-technical repairs could be facilitated to be "plug and play" (such as replacement of an in-room controller) most repairs must be done by a qualified engineer for safety purposes. For this reason, **the cost and complexity of repairs for space heaters is a much more important factor than** for a washing machine or fridge, for example.

A key aspect that arose from discussions was around the length of boiler life versus application of new technologies that are more energy efficient. An old boiler is less energy efficient and so if through availability of spare parts and longer guarantees, older boilers remain in use, some producers felt this **might delay the conversion to newer, more energy efficient technologies**. However, modern boilers are more complex and contain more technical parts, thus increasing the risk of component failure and need to repair as well as a risk of component obsolescence as electronic technology advances.

Boiler producers are keen to use new materials such as lighter plastic composites or to replace heavier cast iron or copper components with aluminium ones. **Making space heaters that are smaller and lighter is a major KPI** to make installs an easier, one-person lift task and also to reduce use of materials and their cost. However, this can impact durability (aluminium corrodes quicker in water) or recyclability if plastic/metal composite materials cannot be separated easily at end-of-life. This is a **delicate balancing act between innovation, durability, efficiency, affordability and also safety**. Producers interviewed felt that these are often opposing demands and were concerned that if cost of manufacture or spare part availability has to be kept low, both these functions would have to be done overseas, impacting UK jobs.

The industry is technologically at a time of great flux and **the future is uncertain**. For installation engineers and producers alike, this is causing difficulty when advising consumers or for the latter, knowing what long -term design decisions they should make.

With the Government considering the banning of new gas-only boilers from being installed from 2026, a prominent layer of uncertainty is felt by those interviewed. **The need for clarity and confidence in the technological route that the UK Government wants to take** will enable installers and producers to invest in the necessary R&D to support a changeover to either hydrogen technology, heat pumps or a hybrid option.

Whilst there is uncertainty, there is a risk of a number of resource efficiency impacts:

- Cheap gas boilers will be installed as a "temporary measure" with these being replaced after just 4-5 years when the newer technology comes on the market creating unnecessary waste
- Boilers being made and fitted now will not have the space inside or technological ability to be retrofitted to convert to hydrogen. Producers cannot invest time and money into R&D and into the testing of new parts from new suppliers if this route is not certain
- Consumers might find themselves in a "no win" position where they cannot afford the new technology but the cost of repairing a 5-year-old boiler is also prohibitive

Advocacy of a hybrid boiler was supported by those interviewed as a stepping-stone to phasing out of old boilers to the new technology at the natural replacement cycle of a boiler system. A hybrid could be a combination of a heat pump and a boiler (potentially a bivalent system where a heat pump and boiler are installed together with overarching controls). The boiler part could then potentially be hydrogen-ready if required, creating a hydrogen boiler / heat pump hybrid.

However, this needs to be recognised and **supported by regulations and investment**.

5 The role of the consumer

The consumer decision to repair or replace is a key influencing factor regarding longevity of use of a product; regardless of how repairable a product is, or the cost or availability of spare parts. As our previous research has shown, products can fail to fulfil their intended lifespan if the consumer chooses due to cost, convenience or fashion that a product is no longer desired. **The need to inform and influence the consumer is one of the areas for further investigation in the UK market**.

Within the scope of this project, a large UK consumer advisory group was interviewed to gain their insights on the role of the consumer in the promotion of resource efficiency of ErP. The association add their own sustainability label to a range of 12 different products with the intention to add this as a deciding criterion at the point of consumer decision – acknowledging that **cost and convenience are still the main two criteria for consumers**. Whilst energy labels have made energy efficiency more visible when considering like-for like replacements, the consumer decision might be different if they are purchasing to solve an urgent problem (replace a broken machine) rather than considering a purchase as a long-term investment.

The consumer advisory group's own sustainability classification is based on the product's ability to perform its base function well but to also be energy or water efficient. The criteria vary by product category, but in general includes assessments also based on good longevity/reliability.

Whilst the consumer advisory group interviewed felt that it was too soon to know if the **Repairability Index** in France will have any effect on consumer choices in the UK, it was felt that this was a **positive development and the ripple effect of making producers look at this aspect** would encourage companies to innovate and raise the bar regarding quality and repairability. However, it was noted, in reflecting on labelling schemes and standards used within the food sector, that a failure to **adopt a single national scheme from the outset** meant that multiple schemes were used by different retailers and manufacturers. This made it difficult for consumers to quickly and easily compare between products and required consumers to have to understand how the different schemes were applied. It took several years before the government brought industry, consumer groups and other stakeholders together to agree a common national scheme for food labelling. So it was felt that **steps could be taken now to avoid this regarding repairability or resource efficiency labelling for ErP**.

Given awareness by the consumer is such a pivotal part of keeping products in use for longer, **labelling was shown to be a critical information point**. The consumer group surveyed a sample of 821 of its members after engaging with sustainability information on dishwashers and washing machines and 95% said they found it either very or fairly helpful as part of their decision-making.

More importantly, 63% reported that the label made them more aware of how a product can be environmentally friendly. This shows the educational benefit of product information at point of purchase – especially in supporting the uncertain/unmotivated consumers to understand better what makes a product eco-friendly and encouraging consideration of purchasing those products.

Robust product data is key to such a scheme being developed that can be applied and be interrogated to avoid any claims of **greenwashing**.

6 Analysis of conflicting ambitions

A fundamental outcome from this work was that the ambitions and objectives that Defra has for the EEE industry are at times conflicting. The complexity and multitude of inter-related aspects makes the challenge of encouraging resource efficiency within the ErP sector, **a complicated challenge where addressing one aspect can have a number of unintended or interconnecting impacts**. These include:

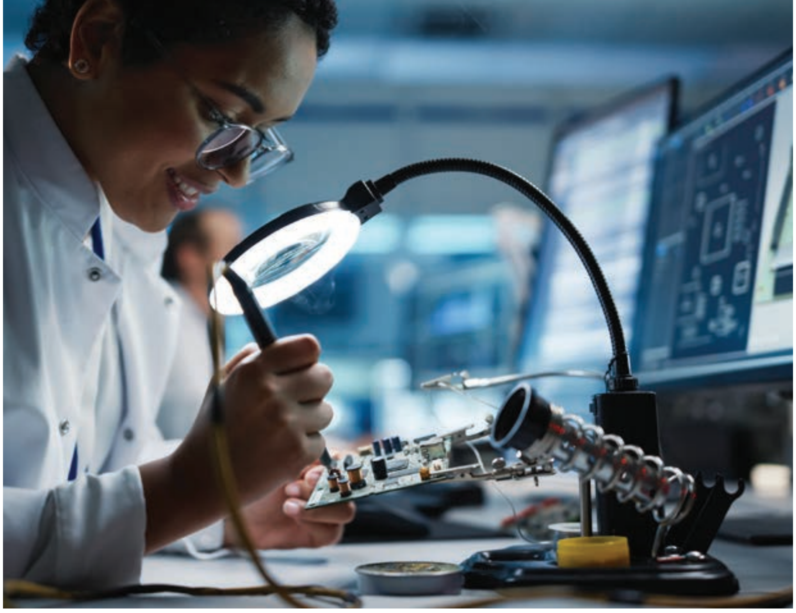
6.1 Energy efficiency vs resource efficiency

Studies conducted in the context of Energy Efficiency Labelling, inter alia co-ordinated by the Joint Research Centre, have demonstrated the **trade-off between replacing energy inefficient products by energy efficient models** (thus resulting in less greenhouse gas emissions and carbon footprint at the expense of more WEEE) and keeping energy inefficient products in longer usage, thus saving on the extraction of materials at the expense of the carbon footprint of the products[31]. This could also be argued to apply more broadly, in the context of other environmental pressures associated with EEE throughout its lifecycle. There will be points, that will vary depending on the product, where **replacing an old inefficient model with a new efficient one may be justified** even when considering the additional environmental impacts of producing a new product and disposing of an old one. However, as the grid decarbonises and given the major energy efficiency advances already realised for many products, this will become less and less relevant.

6.2 Innovation vs product cost

Designing products that facilitate ease of repair or to be upgraded to use **new technologies (as in the case of hydrogen space heating) requires significant investment by producers** in Research & Development. However, producers are also under pressure to offer these new products at the **same or lower prices** in an increasingly competitive and price-sensitive market, now also with the backdrop of the cost-of-living crisis. These opposing demands risk impacting on the consumer by limiting the range of products offered at the lower, entry end of the market, or reductions in the quality of materials used – which in turn can impact on longevity and durability of parts. Similarly, light weighting of items such as washing machines or space heaters to enable easier, quicker installation and use of less resources can impact durability if the thickness of metal or outer coatings in reduced or a composite plastic material is used that is hard to recycle at end-of-life.

31 European Commission. "Sustainable Product Policy". Accessed 31 March 2022. https://joint-research-centre.ec.europa.eu/scientific-activities-z/sustainable-product-policy_en.



6.3 Repairability vs customer convenience

All the producers interviewed expressed a **focus on brand perception and customer experience**. For example a faulty product one month outside guarantee that cannot be repaired, may just be replaced with a new product to maintain consumer good will. This means that a **repairable machine will be scrapped**. In the same way, where retailers offer a "28 day no quibble guarantee" many of the returned products have no fault or something that is very minor and cheap to repair. But these products will be resold on a secondary market and a new product offered rather than repair the original machine.

A secondary aspect is the **time and cost of repair**: for critical products such as washing machines and fridge/freezers, the necessity of the product will greatly restrict the cost and speed at which a repair is acceptable. If the repair is perceived as being too expensive (versus the cost of buying brand new), takes too long or raises doubt of a secondary or recurring fault, a new machine will often be chosen.

6.4 Maturity of product category vs regulatory demands

The maturity of a product category impacts the level of impact that eco-design regulations can have. This is well demonstrated by the space heater sector where the existing gas technology has greatly improved in the last 15 years with improvements made in energy efficiency and already uses materials that are widely recycled by an established scrap metal industry. This is supported by an established servicing and repair industry that is rooted in product safety but has the benefit of maintaining products to keep them working. Here, spare parts being available for longer periods is often already standard practice, meaning an eco-design requirement mandating this may be less impactful. Regulation may have a greater impact on products highlighted in section 2.2 such as microwaves, toasters, grills and food processors. However, as these products are typically low prices items, the challenge will be making repair economically viable.

6.5 UK legislation vs EU legislation

One core common want that came through interviews conducted was for UK legislation and policy requirements to **remain aligned with EU regulations**. Divergence was seen as having a cost impact that would be reflected in product pricing as well as creating challenges for compliance and sales opportunities.

With creation of a labelling scheme for example, producers expressed **the need for alignment with data used across the EU to ensure that UK products do not diverge from EU classifications**. And that additional labels added that do not conform to EU labelling standards which can lead to what one producer called a "Grand Prix of labels". It is suggested that any labelling system be something that can be downloaded at point of sale or data for a website, not a physical label that requires resources to manufacture and remove if a UK product is sold in the EU (which is an issue raised by producers of the existing EU energy labels). This requirement could also align with the **use of the proposed Digital Product Passport** to access product data.

7 Conclusions

7.1 Prioritisation of products

The great variety and complexity of energy-related products (ErP) on the market make it necessary to **prioritise products** for tailored policy interventions aiming at reducing environmental impacts through eco-design. In this study, a **set of 11 environmentally relevant indicators** was developed and applied to **54 product categories** ("UNU-KEYs"), with the aim of identifying ErPs linked to the largest environmental impacts (related to the production and end-of-life stages) that policy interventions shall tackle in priority.

Among the considered indicators, **two were considered as most suitable** due to relatively high environmental relevance and medium-to-high data availability/quality: **WEEE Generated (WG, expressed in tons) and Carbon Footprint (CF, expressed in kgCO2-eq)**. Results show that the relationship between these two metrics is not linear: "electronically-rich" products such as laptops, monitors, TVs, PCs and small household appliances score "above their weight" in terms of carbon footprint, as the production of electronic components is particularly carbon-intensive. Overall, **product types ranking high in the WG and/or CF dimensions** were **ICT equipment, small household equipment, professional cooling equipment, washing machines, fridges, central heating equipment (boilers), radio/hi-fi/music instruments, printers, large cooking equipment and microwave ovens**. Among those product categories, all are already subject to eco-design requirements in the EU and/or the UK except for small equipment for food preparation (e.g. toaster, grills, food processing, frying pans), microwave ovens and printers (e.g. scanners, multi functionals, faxes).

An **important limitation** to the prioritisation exercise conducted here is the **lack of data for many indicators and product categories**. Whereas data for WG of reasonably quality is available for all equipment types, **CF data is missing for many products** including some with large POM figures. For some of the appliances mentioned above, proxies were used for the CF data, and it is recommended to improve the data basis by conducting LCA/CF studies on those product types.

7.2 Ability of eco-design measures to reduce WG and CF impacts

When assessing how eco-design measures can reduce the environmental impacts of ErP, it depends on the metric used for measurement of success (WG or CF) and the anticipated timescales:

Reduce WG – Longer timescale

Physical design changes required by eco-design regulations will not actually start to impact on WG of new products for, depending on product lifetimes and including the time to implement regulations, **a minimum of 6/7 years** for products with relatively short lifespans of **3-5 years** such as smartphones, peripherals, and laptops or longer for products with longer lifespans.

Design requirements to enable better recovery of materials and components at end-of-life reduces waste and has an additional CF benefit but also have **a longer time to realise the benefit. Requirements intended to extend the lifetimes of existing stock are therefore clearly preferable** in terms of time to impact, but that would exclude requirements focussed on the physical design of products.

Reduce CF – Shorter timescale

Eco-design requirements focussed on the physical design and production, through decarbonisation of materials and processes, **have the potential to directly reduce the carbon footprint of EEE in a shorter timeframe**. As most EEE is imported, such measures would only contribute minimally to the UK's Net Zero targets, however they would support the global need to address carbon emissions. One example of an effective design requirement would be a minimum of recycled content as this would also support the development of the recycling industry in the UK. Alternative measures/instruments such as **eco-labelling (e.g. the use of a repairability index or low carbon mark) also has the potential be impactful in the shorter term by influencing consumer product choices and encouraging competition between producers for better scores.**

In conclusion, lifetime extension measures for products that have the highest CF and WG and that are already on the market would have maximum impact in the shortest timescale, as detailed in Section 7.1.

7.3 One size does not fit all

The different type of categories within ErP means that **one approach does not suit the whole sector**. Activities that might need to be encouraged for one category of products can be commonplace established practice in another. **Regulatory policies therefore need to reflect this nuance** and tailor the approaches needed depending on a multitude of factors. These include the complexity of the product category, whether the technology is new or established, the maturity of the market, other prevalent policy requirements such as safety that take priority and the infrastructure that is in place for repair or recycling. For example, space heaters are more technically complex and are tightly governed by strict rules for gas safety. They cannot be repaired by the public; they are made predominantly of widely recycled metals and the spare parts market is well established and effective. The technology of the gas boiler design has also developed extensively so that external factors such as the controls or user functions of the boiler now have the greatest scope for reducing impact. This is different to IT products, which as a contrast, have a lot of scope to be repaired or upgraded by the consumer and whose parts are harder to recycle due to containing a lot of plastic and electronic circuitry. The repair market for IT products was also seen to be very different to the washing machine market. Both are essential items and yet IT products are more complex and at a greater risk of technologically becoming outdated as consumers want lighter, slimmer, faster products.

Based on the input from the representatives of the product categories interviewed, a nuanced approach is therefore needed when considering the type of eco-design regulations to apply to each product category.

7.4 Need for minimum standards

As the eco-modulation modelling conducted showed, incentivising **life extension through reward at end-of-life is likely to be less effective** in making a real impact. A more immediate way of delivering impact would be for eco-design regulations to **offer minimum standards** that a producer must comply with. These regulations need to be clear and facilitate direct action such as setting a minimum operational lifetime that is supported by repairability or legislating against materials that hinder the repairability of products. Products under guarantee or extended warrantee are more likely to be repaired so the requirement to offer **spare parts supports the expansion of this scenario**. For product categories that already offer lengthy availability of spare parts, regulating on spare parts will formalise existing best practice and set an industry standard. For **product categories that have a lower product value and low economic repair value, this would be ground-breaking territory** – such as toasters and food processors. However, the challenge here will be to make this economically viable.

7.5 Use of labels / information

The provision of information on product repairability needs to be communicated through an effective use of labelling, as is currently done for energy efficiency of products. **Consumer education and awareness is key** to keeping products in use for longer through repairability or choice of the right product when purchasing. The points of intervention include:

- **Engineer advice** – for product categories such as space heaters, cookers and washing machines, the expert advice given to the consumer can determine if a product is repaired or replaced. Similarly, if choosing a new product, the provision of a product label could, as is seen with energy labels, be used by engineers to give advice and aid in the comparison of similar products based on repairability or life-extension.
- **Point of purchase information** – creation of a credible system that all producers use to give consumers clear, credible ratings based on sustainability credentials to influence choice at the point of purchase (both online and in-store). The development of such a label with ratings that uses a similar method to that of the EU for the Repairability Index could make it easier for producers to use existing worldwide data held.

8 Annex

8.1 Prioritisation metrics (excerpts from prioritisation tool)

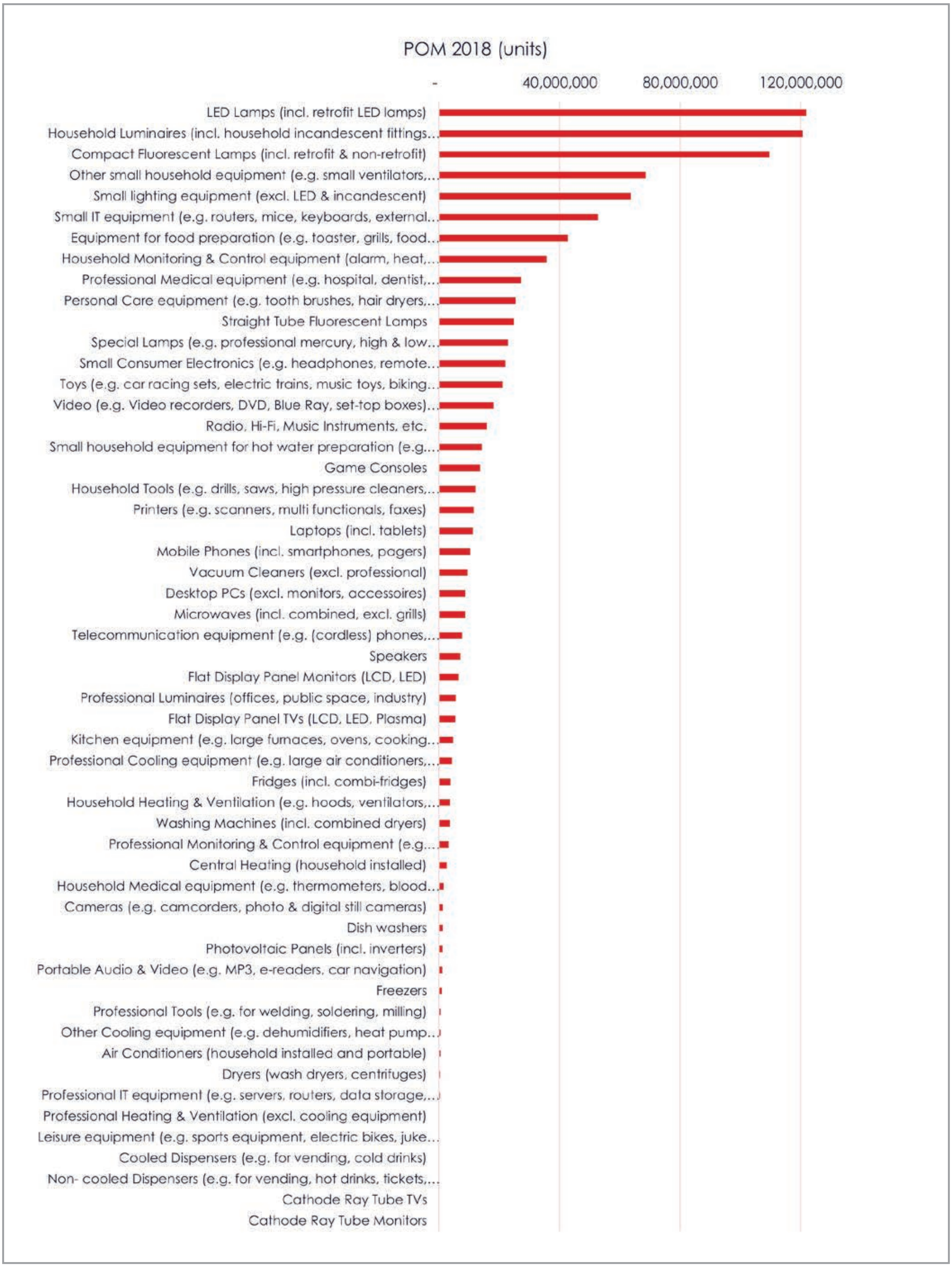
UNU-KEY	Description	Existing UK/EU Eco-design Legislation	POM trend (CAGR 2015-2020)	WEEE Generated 2018 (tons)	WG trend (CAGR 2015-2020)	Carbon Footprint of production (kilotons CO2-eq)	CRM score	Prob-lematic substances score
0104	Washing Machines (incl. combined dryers)	yes	2%	161,875	3%	1,326	-	-
0108	Fridges (incl. combi-fridges)	yes	1%	130,390	3%	1,005	-	2
0114	Microwaves (incl. combined, excl. grills)	no	0%	79,193	3%	489	-	1
0506	Household Luminaires (incl. household incandescent fittings & household LED luminaires)	yes	3%	79,012	4%	-	-	-
0202	Equipment for food preparation (e.g. toaster, grills, food processing, frying pans)	no	3%	77,976	3%	1,748	-	-
0407	Cathode Ray Tube TVs	no	0%	67,223	-7%	-	1	2
0103	Kitchen equipment (e.g. large furnaces, ovens, cooking equipment)	yes	-1%	64,389	3%	688	-	-
0304	Printers (e.g. scanners, multi functionals, faxes)	no	-2%	62,240	2%	711	-	1
0105	Dryers (wash dryers, centrifuges)	yes	2%	53,917	1%	72	-	-
0201	Other small household equipment (e.g. small ventilators, irons, clocks, adapters)	yes	0%	50,695	4%	2,126	-	-
0408	Flat Display Panel TVs (LCD, LED, Plasma)	yes	-5%	49,438	7%	1,974	1	4
0102	Dish washers	yes	-1%	45,272	1%	168	-	-
0308	Cathode Ray Tube Monitors	no	0%	44,942	-11%	-	1	2
0001	Central Heating (household installed)	yes	-2%	43,229	3%	1,207	-	-
0302	Desktop PCs (excl. monitors, accessoires)	yes	-9%	41,574	-2%	1,877	2	4
0204	Vacuum Cleaners (excl. professional)	yes	2%	39,299	2%	294	-	-
0109	Freezers	yes	1%	38,522	0%	225	-	2
0106	Household Heating & Ventilation (e.g. hoods, ventilators, space heaters)	yes	2%	36,569	2%	211	-	-

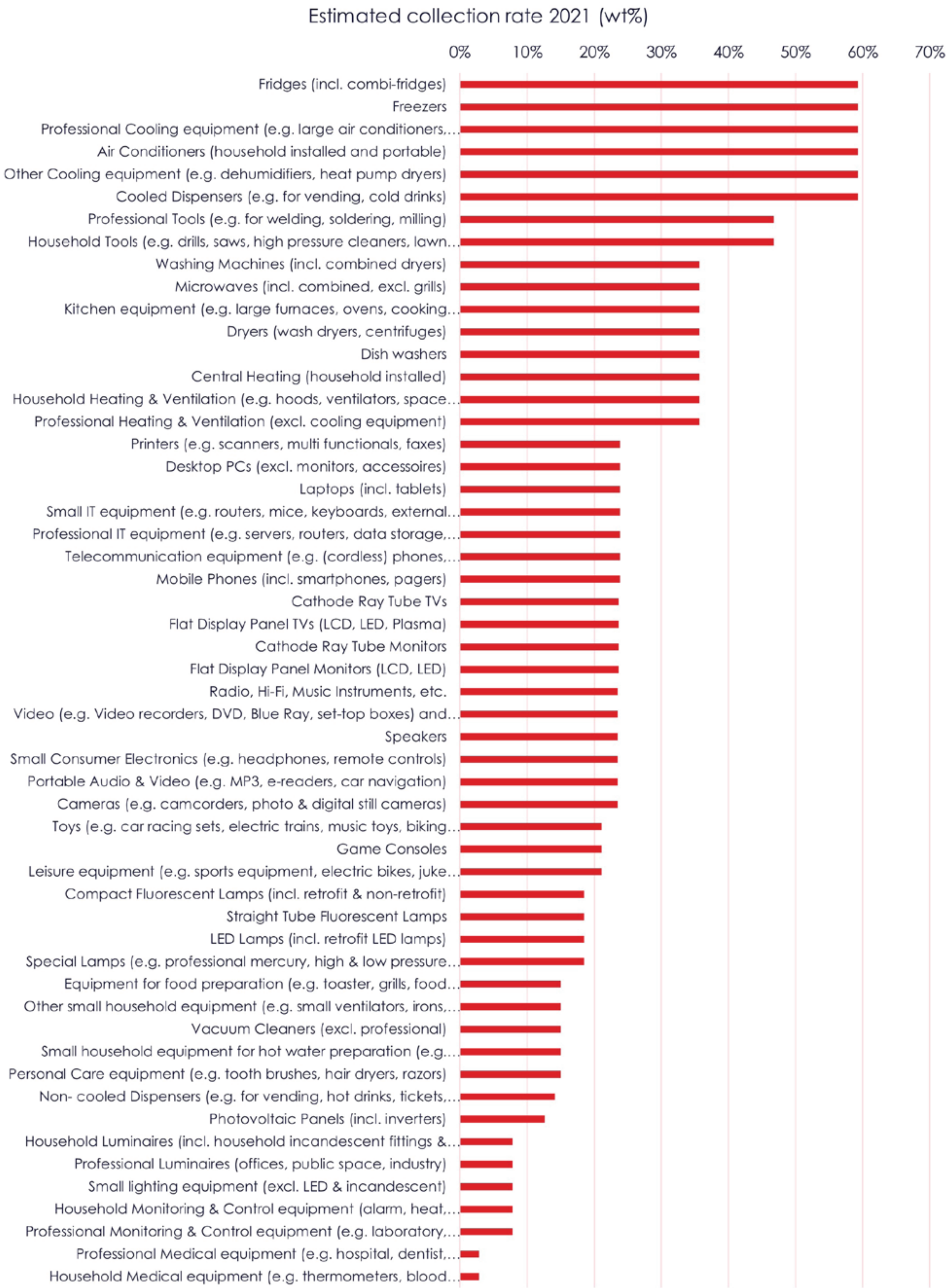
0113	Professional Cooling equipment (e.g. large air conditioners, cooling displays)	yes	-1%	35,209	6%	2,108	-	2
0403	Radio, Hi-Fi, Music Instruments, etc.	no	-4%	33,504	2%	832	-	-
0404	Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and projectors	yes	1%	29,466	-2%	423	-	-
0602	Professional Tools (e.g. for welding, soldering, milling)	yes	2%	29,195	-1%	-	-	1
0309	Flat Display Panel Monitors (LCD, LED)	yes	-3%	23,820	8%	2,390	1	4
0303	Laptops (incl. tablets)	yes	-1%	23,078	-1%	1,899	2	4
0203	Small household equipment for hot water preparation (e.g. coffee, tea, water cookers)	no	1%	18,892	6%	582	-	-
0405	Speakers	no	0%	17,762	1%	368	-	-
0601	Household Tools (e.g. drills, saws, high pressure cleaners, lawn mowers)	yes	1%	15,724	16%	373	-	1
0301	Small IT equipment (e.g. routers, mice, keyboards, external drives & accessories)	yes	0%	14,591	1%	362	-	-
0901	Household Monitoring & Control equipment (alarm, heat, smoke, excl. screens)	no	0%	13,327	4%	-	-	1
0111	Air Conditioners (household installed and portable)	yes	1%	12,924	0%	100	-	2
0701	Toys (e.g. car racing sets, electric trains, music toys, biking computers, drones)	no	2%	11,403	-3%	-	-	-
0702	Game Consoles	no	-4%	10,530	1%	-	-	-
0205	Personal Care equipment (e.g. tooth brushes, hair dryers, razors)	no	-3%	10,357	1%	167	-	1
0307	Professional IT equipment (e.g. servers, routers, data storage, copiers)	yes	-3%	10,074	-6%	73	-	-
0802	Professional Medical equipment (e.g. hospital, dentist, diagnostics)	no	6%	9,678	-4%	-	-	-
0502	Compact Fluorescent Lamps (incl. retrofit & non-retrofit)	yes	-3%	8,017	0%	406	2	4
0507	Professional Luminaires (offices, public space, industry)	no	1%	7,472	3%	-	-	-

0112	Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)	no	9%	6,999	1%	81	-	2
0503	Straight Tube Fluorescent Lamps	yes	-1%	6,139	-4%	91	2	4
0305	Telecommunication equipment (e.g. (cordless) phones, answering machines)	no	2%	5,745	-5%	291	-	-
1002	Cooled Dispensers (e.g. for vending, cold drinks)	no	1%	5,677	-1%	-	-	2
0501	Small lighting equipment (excl. LED & incandescent)	yes	3%	4,704	1%	-	-	-
0401	Small Consumer Electronics (e.g. headphones, remote controls)	yes	-2%	4,543	3%	151	-	-
0505	LED Lamps (incl. retrofit LED lamps)	yes	6%	4,462	17%	292	1	-
0306	Mobile Phones (incl. smartphones, pagers)	no	0%	3,212	-3%	391	2	1
0504	Special Lamps (e.g. professional mercury, high & low pressure sodium)	yes	0%	2,844	-1%	84	-	4
0101	Professional Heating & Ventilation (excl. cooling equipment)	yes	-3%	2,378	-2%	58	-	-
0402	Portable Audio & Video (e.g. MP3, e-readers, car navigation)	no	-3%	1,983	-7%	48	-	-
0406	Cameras (e.g. camcorders, photo & digital still cameras)	no	-5%	1,618	-7%	69	1	1
1001	Non- cooled Dispensers (e.g. for vending, hot drinks, tickets, money)	no	5%	1,058	-8%	-	-	-
0002	Photovoltaic Panels (incl. inverters)	no	-17%	1,046	43%	68	-	-
0902	Professional Monitoring & Control equipment (e.g. laboratory, control panels)	no	1%	789	9%	-	-	-
0801	Household Medical equipment (e.g. thermometers, blood pressure meters)	no	1%	166	0%	-	-	-
0703	Leisure equipment (e.g. sports equipment, electric bikes, juke boxes)	no	1%	64	80%	-	-	-

POM 2018 (tons)
-
50,000
100,000
150,000
200,000
250,000
Washing Machines (incl. combined dryers)
Fridges (incl. combi-fridges)
Household Luminaires (incl. household incandescent fittings &...
Equipment for food preparation (e.g. toaster, grills, food...
Kitchen equipment (e.g. large furnaces, ovens, cooking...
Microwaves (incl. combined, excl. grills)
Other small household equipment (e.g. small ventilators, irons,...
Professional Cooling equipment (e.g. large air conditioners,...
Central Heating (household installed)
Printers (e.g. scanners, multi functionals, faxes)
Household Heating & Ventilation (e.g. hoods, ventilators,...
Vacuum Cleaners (excl. professional)
Dish washers
Flat Display Panel TVs (LCD, LED, Plasma)
Household Tools (e.g. drills, saws, high pressure cleaners, lawn...
Radio, Hi-Fi, Music Instruments, etc.
Freezers
Desktop PCs (excl. monitors, accessoires)
Small household equipment for hot water preparation (e.g....
Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes)...
Flat Display Panel Monitors (LCD, LED)
Speakers
Laptops (incl. tablets)
Photovoltaic Panels (incl. inverters)
Household Monitoring & Control equipment (alarm, heat,...
Small IT equipment (e.g. routers, mice, keyboards, external...
Air Conditioners (household installed and portable)
Dryers (wash dryers, centrifuges)
Professional Luminaires (offices, public space, industry)
Game Consoles
Toys (e.g. car racing sets, electric trains, music toys, biking...
Personal Care equipment (e.g. tooth brushes, hair dryers, razors)
Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)
LED Lamps (incl. retrofit LED lamps)
Compact Fluorescent Lamps (incl. retrofit & non-retrofit)
Professional IT equipment (e.g. servers, routers, data storage,...
Professional Tools (e.g. for welding, soldering, milling)
Small lighting equipment (excl. LED & incandescent)
Small Consumer Electronics (e.g. headphones, remote controls)
Professional Medical equipment (e.g. hospital, dentist,...
Cooled Dispensers (e.g. for vending, cold drinks)
Telecommunication equipment (e.g. (cordless) phones,...
Straight Tube Fluorescent Lamps
Mobile Phones (incl. smartphones, pagers)
Special Lamps (e.g. professional mercury, high & low pressure...
Professional Monitoring & Control equipment (e.g. laboratory,...
Professional Heating & Ventilation (excl. cooling equipment)
Portable Audio & Video (e.g. MP3, e-readers, car navigation)
Non- cooled Dispensers (e.g. for vending, hot drinks, tickets,...
Cameras (e.g. camcorders, photo & digital still cameras)
Leisure equipment (e.g. sports equipment, electric bikes, juke...
Household Medical equipment (e.g. thermometers, blood...
Cathode Ray Tube TVs
Cathode Ray Tube Monitors


WEEE Generated 2018 (tons)
-
40,000
80,000
120,000
160,000
Washing Machines (incl. combined dryers)
Fridges (incl. combi-fridges)
Microwaves (incl. combined, excl. grills)
Household Luminaires (incl. household incandescent fittings &...
Equipment for food preparation (e.g. toaster, grills, food...
Cathode Ray Tube TVs
Kitchen equipment (e.g. large furnaces, ovens, cooking...
Printers (e.g. scanners, multi functionals, faxes)
Dryers (wash dryers, centrifuges)
Other small household equipment (e.g. small ventilators, irons,...
Flat Display Panel TVs (LCD, LED, Plasma)
Dish washers
Cathode Ray Tube Monitors
Central Heating (household installed)
Desktop PCs (excl. monitors, accessoires)
Vacuum Cleaners (excl. professional)
Freezers
Household Heating & Ventilation (e.g. hoods, ventilators,...
Professional Cooling equipment (e.g. large air conditioners,...
Radio, Hi-Fi, Music Instruments, etc.
Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes)...
Professional Tools (e.g. for welding, soldering, milling)
Flat Display Panel Monitors (LCD, LED)
Laptops (incl. tablets)
Small household equipment for hot water preparation (e.g....
Speakers
Household Tools (e.g. drills, saws, high pressure cleaners, lawn...
Small IT equipment (e.g. routers, mice, keyboards, external...
Household Monitoring & Control equipment (alarm, heat,...
Air Conditioners (household installed and portable)
Toys (e.g. car racing sets, electric trains, music toys, biking...
Game Consoles
Personal Care equipment (e.g. tooth brushes, hair dryers, razors)
Professional IT equipment (e.g. servers, routers, data storage,...
Professional Medical equipment (e.g. hospital, dentist,...
Compact Fluorescent Lamps (incl. retrofit & non-retrofit)
Professional Luminaires (offices, public space, industry)
Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)
Straight Tube Fluorescent Lamps
Telecommunication equipment (e.g. (cordless) phones,...
Cooled Dispensers (e.g. for vending, cold drinks)
Small lighting equipment (excl. LED & incandescent)
Small Consumer Electronics (e.g. headphones, remote controls)
LED Lamps (incl. retrofit LED lamps)
Mobile Phones (incl. smartphones, pagers)
Special Lamps (e.g. professional mercury, high & low pressure...
Professional Heating & Ventilation (excl. cooling equipment)
Portable Audio & Video (e.g. MP3, e-readers, car navigation)
Cameras (e.g. camcorders, photo & digital still cameras)
Non- cooled Dispensers (e.g. for vending, hot drinks, tickets,...
Photovoltaic Panels (incl. inverters)
Professional Monitoring & Control equipment (e.g. laboratory,...
Household Medical equipment (e.g. thermometers, blood...
Leisure equipment (e.g. sports equipment, electric bikes, juke...


POM 2018 (units)
-
40,000,000
80,000,000
120,000,000
LED Lamps (incl. retrofit LED lamps)
Household Luminaires (incl. household incandescent fittings...
Compact Fluorescent Lamps (incl. retrofit & non-retrofit)
Other small household equipment (e.g. small ventilators,...
Small lighting equipment (excl. LED & incandescent)
Small IT equipment (e.g. routers, mice, keyboards, external...
Equipment for food preparation (e.g. toaster, grills, food...
Household Monitoring & Control equipment (alarm, heat,...
Professional Medical equipment (e.g. hospital, dentist,...
Personal Care equipment (e.g. tooth brushes, hair dryers,...
Straight Tube Fluorescent Lamps
Special Lamps (e.g. professional mercury, high & low...
Small Consumer Electronics (e.g. headphones, remote...
Toys (e.g. car racing sets, electric trains, music toys, biking...
Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes)...
Radio, Hi-Fi, Music Instruments, etc.
Small household equipment for hot water preparation (e.g...
Game Consoles
Household Tools (e.g. drills, saws, high pressure cleaners,...
Printers (e.g. scanners, multi functionals, faxes)
Laptops (incl. tablets)
Mobile Phones (incl. smartphones, pagers)
Vacuum Cleaners (excl. professional)
Desktop PCs (excl. monitors, accessoires)
Microwaves (incl. combined, excl. grills)
Telecommunication equipment (e.g. (cordless) phones,...
Speakers
Flat Display Panel Monitors (LCD, LED)
Professional Luminaires (offices, public space, industry)
Flat Display Panel TVs (LCD, LED, Plasma)
Kitchen equipment (e.g. large furnaces, ovens, cooking...
Professional Cooling equipment (e.g. large air conditioners,...
Fridges (incl. combi-fridges)
Household Heating & Ventilation (e.g. hoods, ventilators,...
Washing Machines (incl. combined dryers)
Professional Monitoring & Control equipment (e.g...
Central Heating (household installed)
Household Medical equipment (e.g. thermometers, blood...
Cameras (e.g. camcorders, photo & digital still cameras)
Dish washers
Photovoltaic Panels (incl. inverters)
Portable Audio & Video (e.g. MP3, e-readers, car navigation)
Freezers
Professional Tools (e.g. for welding, soldering, milling)
Other Cooling equipment (e.g. dehumidifiers, heat pump...
Air Conditioners (household installed and portable)
Dryers (wash dryers, centrifuges)
Professional IT equipment (e.g. servers, routers, data storage,...
Professional Heating & Ventilation (excl. cooling equipment)
Leisure equipment (e.g. sports equipment, electric bikes, juke...
Cooled Dispensers (e.g. for vending, cold drinks)
Non- cooled Dispensers (e.g. for vending, hot drinks, tickets,...
Cathode Ray Tube TVs
Cathode Ray Tube Monitors



Estimated collection rate 2021 (wt%)
0%
10%
20%
30%
40%
50%
60%
70%
Fridges (incl. combi-fridges)
Freezers
Professional Cooling equipment (e.g. large air conditioners,…
Air Conditioners (household installed and portable)
Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)
Cooled Dispensers (e.g. for vending, cold drinks)
Professional Tools (e.g. for welding, soldering, milling)
Household Tools (e.g. drills, saws, high pressure cleaners, lawn…
Washing Machines (incl. combined dryers)
Microwaves (incl. combined, excl. grills)
Kitchen equipment (e.g. large furnaces, ovens, cooking…
Dryers (wash dryers, centrifuges)
Dish washers
Central Heating (household installed)
Household Heating & Ventilation (e.g. hoods, ventilators, space…
Professional Heating & Ventilation (excl. cooling equipment)
Printers (e.g. scanners, multi functionals, faxes)
Desktop PCs (excl. monitors, accessoires)
Laptops (incl. tablets)
Small IT equipment (e.g. routers, mice, keyboards, external…
Professional IT equipment (e.g. servers, routers, data storage,…
Telecommunication equipment (e.g. (cordless) phones,…
Mobile Phones (incl. smartphones, pagers)
Cathode Ray Tube TVs
Flat Display Panel TVs (LCD, LED, Plasma)
Cathode Ray Tube Monitors
Flat Display Panel Monitors (LCD, LED)
Radio, Hi-Fi, Music Instruments, etc.
Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and…
Speakers
Small Consumer Electronics (e.g. headphones, remote controls)
Portable Audio & Video (e.g. MP3, e-readers, car navigation)
Cameras (e.g. camcorders, photo & digital still cameras)
Toys (e.g. car racing sets, electric trains, music toys, biking…
Game Consoles
Leisure equipment (e.g. sports equipment, electric bikes, juke…
Compact Fluorescent Lamps (incl. retrofit & non-retrofit)
Straight Tube Fluorescent Lamps
LED Lamps (incl. retrofit LED lamps)
Special Lamps (e.g. professional mercury, high & low pressure…
Equipment for food preparation (e.g. toaster, grills, food…
Other small household equipment (e.g. small ventilators, irons,…
Vacuum Cleaners (excl. professional)
Small household equipment for hot water preparation (e.g.…
Personal Care equipment (e.g. tooth brushes, hair dryers, razors)
Non- cooled Dispensers (e.g. for vending, hot drinks, tickets,…
Photovoltaic Panels (incl. inverters)
Household Luminaires (incl. household incandescent fittings &…
Professional Luminaires (offices, public space, industry)
Small lighting equipment (excl. LED & incandescent)
Household Monitoring & Control equipment (alarm, heat,…
Professional Monitoring & Control equipment (e.g. laboratory,…
Professional Medical equipment (e.g. hospital, dentist,…
Household Medical equipment (e.g. thermometers, blood…

Carbon footprint (kilotons CO2-eq) - production only
-
500
1,000
1,500
2,000
2,500
3,000
Flat Display Panel Monitors (LCD, LED)
Other small household equipment (e.g. small ventilators, irons,...
Professional Cooling equipment (e.g. large air conditioners,...
Flat Display Panel TVs (LCD, LED, Plasma)
Laptops (incl. tablets)
Desktop PCs (excl. monitors, accessoires)
Equipment for food preparation (e.g. toaster, grills, food...
Washing Machines (incl. combined dryers)
Central Heating (household installed)
Fridges (incl. combi-fridges)
Music Instruments, Radio, Hi-Fi (incl. audio sets)
Printers (e.g. scanners, multi functionals, faxes)
Kitchen equipment (e.g. large furnaces, ovens, cooking...
Small household equipment for hot water preparation (e.g....
Microwaves (incl. combined, excl. grills)
Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes)...
Compact Fluorescent Lamps (incl. retrofit & non-retrofit)
Mobile Phones (incl. smartphones, pagers)
Household Tools (e.g. drills, saws, high pressure cleaners, lawn...
Speakers
Small IT equipment (e.g. routers, mice, keyboards, external...
Vacuum Cleaners (excl. professional)
LED Lamps (incl. retrofit LED lamps)
Telecommunication equipment (e.g. (cordless) phones,...
Freezers
Household Heating & Ventilation (e.g. hoods, ventilators,...
Dish washers
Personal Care equipment (e.g. tooth brushes, hair dryers, razors)
Small Consumer Electronics (e.g. headphones, remote controls)
Air Conditioners (household installed and portable)
Straight Tube Fluorescent Lamps
Special Lamps (e.g. professional mercury, high & low pressure...
Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)
Professional IT equipment (e.g. servers, routers, data storage,...
Dryers (wash dryers, centrifuges)
Cameras (e.g. camcorders, photo & digital still cameras)
Photovoltaic Panels (incl. inverters)
Professional Heating & Ventilation (excl. cooling equipment)
Portable Audio & Video (e.g. MP3, e-readers, car navigation)
Household Luminaires (incl. household incandescent fittings &...
Household Monitoring & Control equipment (alarm, heat,...
Professional Luminaires (offices, public space, industry)
Game Consoles
Toys (e.g. car racing sets, electric trains, music toys, biking...
Professional Tools (e.g. for welding, soldering, milling)
Small lighting equipment (excl. LED & incandescent)
Professional Medical equipment (e.g. hospital, dentist,...
Cooled Dispensers (e.g. for vending, cold drinks)
Professional Monitoring & Control equipment (e.g. laboratory,...
Non- cooled Dispensers (e.g. for vending, hot drinks, tickets,...
Leisure equipment (e.g. sports equipment, electric bikes, juke...
Household Medical equipment (e.g. thermometers, blood...
Cathode Ray Tube Monitors
Cathode Ray Tube TVs


Abiotic resource depletion (tons Sb-eq) - production only
-
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
Equipment for food preparation (e.g. toaster, grills, food...
Small household equipment for hot water preparation (e.g....
Kitchen equipment (e.g. large furnaces, ovens, cooking...
Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes)...
Small IT equipment (e.g. routers, mice, keyboards, external...
LED Lamps (incl. retrofit LED lamps)
Household Heating & Ventilation (e.g. hoods, ventilators,...
Flat Display Panel Monitors (LCD, LED)
Personal Care equipment (e.g. tooth brushes, hair dryers, razors)
Small Consumer Electronics (e.g. headphones, remote controls)
Flat Display Panel TVs (LCD, LED, Plasma)
Desktop PCs (excl. monitors, accessoires)
Laptops (incl. tablets)
Professional Cooling equipment (e.g. large air conditioners,...
Radio, Hi-Fi, Music Instruments, etc.
Central Heating (household installed)
Other small household equipment (e.g. small ventilators, irons,...
Compact Fluorescent Lamps (incl. retrofit & non-retrofit)
Speakers
Washing Machines (incl. combined dryers)
Microwaves (incl. combined, excl. grills)
Fridges (incl. combi-fridges)
Printers (e.g. scanners, multi functionals, faxes)
Straight Tube Fluorescent Lamps
Dish washers
Special Lamps (e.g. professional mercury, high & low pressure...
Household Tools (e.g. drills, saws, high pressure cleaners, lawn...
Vacuum Cleaners (excl. professional)
Cameras (e.g. camcorders, photo & digital still cameras)
Professional IT equipment (e.g. servers, routers, data storage,...
Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)
Dryers (wash dryers, centrifuges)
Portable Audio & Video (e.g. MP3, e-readers, car navigation)
Freezers
Mobile Phones (incl. smartphones, pagers)
Telecommunication equipment (e.g. (cordless) phones,...
Professional Heating & Ventilation (excl. cooling equipment)
Air Conditioners (household installed and portable)
Photovoltaic Panels (incl. inverters)
Household Luminaires (incl. household incandescent fittings &...
Small lighting equipment (excl. LED & incandescent)
Household Monitoring & Control equipment (alarm, heat,...
Professional Medical equipment (e.g. hospital, dentist,...
Toys (e.g. car racing sets, electric trains, music toys, biking...
Game Consoles
Professional Luminaires (offices, public space, industry)
Professional Monitoring & Control equipment (e.g. laboratory,...
Household Medical equipment (e.g. thermometers, blood...
Professional Tools (e.g. for welding, soldering, milling)
Leisure equipment (e.g. sports equipment, electric bikes, juke...
Cooled Dispensers (e.g. for vending, cold drinks)
Non- cooled Dispensers (e.g. for vending, hot drinks, tickets,...
Cathode Ray Tube TVs
Cathode Ray Tube Monitors

Aggregated impact (million ReCiPe points)
-
100
200
300
400
500
600
700
Professional Cooling equipment (e.g. large air conditioners,...
Flat Display Panel Monitors (LCD, LED)
Flat Display Panel TVs (LCD, LED, Plasma)
Desktop PCs (excl. monitors, accessoires)
Central Heating (household installed)
Other small household equipment (e.g. small ventilators, irons,...
Laptops (incl. tablets)
Washing Machines (incl. combined dryers)
Equipment for food preparation (e.g. toaster, grills, food...
Fridges (incl. combi-fridges)
Radio, Hi-Fi, Music Instruments, etc.
Kitchen equipment (e.g. large furnaces, ovens, cooking...
Compact Fluorescent Lamps (incl. retrofit & non-retrofit)
Microwaves (incl. combined, excl. grills)
Printers (e.g. scanners, multi functionals, faxes)
Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and...
Speakers
Small household equipment for hot water preparation (e.g....
Small IT equipment (e.g. routers, mice, keyboards, external...
Household Heating & Ventilation (e.g. hoods, ventilators, space...
Household Tools (e.g. drills, saws, high pressure cleaners, lawn...
Dish washers
Mobile Phones (incl. smartphones, pagers)
Vacuum Cleaners (excl. professional)
Freezers
Telecommunication equipment (e.g. (cordless) phones,...
Straight Tube Fluorescent Lamps
Personal Care equipment (e.g. tooth brushes, hair dryers, razors)
Special Lamps (e.g. professional mercury, high & low pressure...
Small Consumer Electronics (e.g. headphones, remote controls)
Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)
Dryers (wash dryers, centrifuges)
Air Conditioners (household installed and portable)
Professional Heating & Ventilation (excl. cooling equipment)
Professional IT equipment (e.g. servers, routers, data storage,...
Cameras (e.g. camcorders, photo & digital still cameras)
Portable Audio & Video (e.g. MP3, e-readers, car navigation)
Photovoltaic Panels (incl. inverters)
LED Lamps (incl. retrofit LED lamps)
Household Luminaires (incl. household incandescent fittings &...
Small lighting equipment (excl. LED & incandescent)
Household Monitoring & Control equipment (alarm, heat,...
Professional Medical equipment (e.g. hospital, dentist,...
Toys (e.g. car racing sets, electric trains, music toys, biking...
Game Consoles
Professional Luminaires (offices, public space, industry)
Professional Monitoring & Control equipment (e.g. laboratory,...
Household Medical equipment (e.g. thermometers, blood...
Professional Tools (e.g. for welding, soldering, milling)
Leisure equipment (e.g. sports equipment, electric bikes, juke...
Cooled Dispensers (e.g. for vending, cold drinks)
Non- cooled Dispensers (e.g. for vending, hot drinks, tickets,...
Cathode Ray Tube TVs
Cathode Ray Tube Monitors

Simplified EoL Carbon Footprint (kilotons CO2-eq)
-
10
20
30
40
50
60
70
80
90
Fridges (incl. combi-fridges)
Washing Machines (incl. combined dryers)
Printers (e.g. scanners, multi functionals, faxes)
Freezers
Equipment for food preparation (e.g. toaster, grills, food...
Professional Cooling equipment (e.g. large air conditioners,...
Cathode Ray Tube TVs
Desktop PCs (excl. monitors, accessoires)
Professional Tools (e.g. for welding, soldering, milling)
Microwaves (incl. combined, excl. grills)
Other small household equipment (e.g. small ventilators, irons,...
Flat Display Panel TVs (LCD, LED, Plasma)
Kitchen equipment (e.g. large furnaces, ovens, cooking...
Cathode Ray Tube Monitors
Radio, Hi-Fi, Music Instruments, etc.
Dryers (wash dryers, centrifuges)
Vacuum Cleaners (excl. professional)
Video (e.g. Video recorders, DVD, Blue Ray, set-top boxes) and...
Dish washers
Laptops (incl. tablets)
Household Tools (e.g. drills, saws, high pressure cleaners, lawn...
Central Heating (household installed)
Air Conditioners (household installed and portable)
Household Luminaires (incl. household incandescent fittings &...
Household Heating & Ventilation (e.g. hoods, ventilators, space...
Flat Display Panel Monitors (LCD, LED)
Speakers
Small IT equipment (e.g. routers, mice, keyboards, external...
Small household equipment for hot water preparation (e.g....
Toys (e.g. car racing sets, electric trains, music toys, biking...
Game Consoles
Other Cooling equipment (e.g. dehumidifiers, heat pump dryers)
Professional IT equipment (e.g. servers, routers, data storage,...
Compact Fluorescent Lamps (incl. retrofit & non-retrofit)
Household Monitoring & Control equipment (alarm, heat,...
Cooled Dispensers (e.g. for vending, cold drinks)
Personal Care equipment (e.g. tooth brushes, hair dryers, razors)
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Special Lamps (e.g. professional mercury, high & low pressure...
Mobile Phones (incl. smartphones, pagers)
Professional Luminaires (offices, public space, industry)
Portable Audio & Video (e.g. MP3, e-readers, car navigation)
Cameras (e.g. camcorders, photo & digital still cameras)
Professional Heating & Ventilation (excl. cooling equipment)
Small lighting equipment (excl. LED & incandescent)
Professional Medical equipment (e.g. hospital, dentist,...
Professional Monitoring & Control equipment (e.g. laboratory,...
Non- cooled Dispensers (e.g. for vending, hot drinks, tickets,...
Photovoltaic Panels (incl. inverters)
Leisure equipment (e.g. sports equipment, electric bikes, juke...
Household Medical equipment (e.g. thermometers, blood...

8.2 EU's methodology for the prioritisation of product groups in the most recent Preparatory Study for the Eco-design and Energy Labelling Working Plan 2020-2024[32]

An initial screening of a long list of products[33] through the establishment of matrix to filter groups mainly based on existing regulations, potential overlap with other policies, and other regulatory relevance, as well as economic significance (volume of sales), environmental significance (production: materials, recycled content; use: energy, carbon emissions, auxiliaries; reuse, repair life; EoL recycle, recover waste); and significant saving potential (environmental savings potential; absence of market failure; wide disparity in environmental performance)—as illustrated in the table below: Task 3 consisted of the following basic steps:

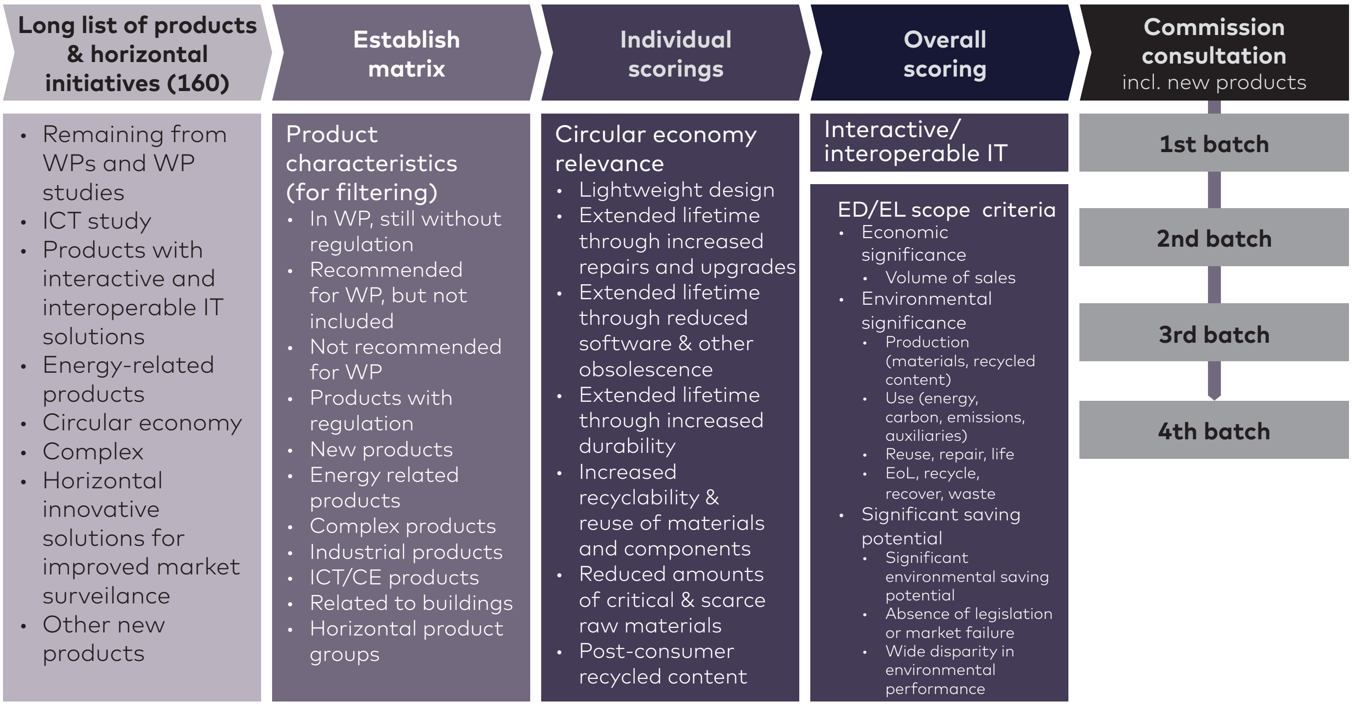

Figure 8: Illustrative overview of methodology and process for establishing the lists of product groups and horizontal initiatives to be assessed in Task 3.

Once this initial screening occurred, the 160 product groups assessed were then reduced to 31 product groups to be analysed in further detail in the next task (Task 3: Preliminary Analysis of Product Groups and Horizontal Initiatives). Task 3 performed the first analysis of the product groups and initiatives identified in Task 2 in terms of sales, trade and stock resource consumption, the technical-economic improvement potential and a check of whether the results indicate that the product or initiative is within the scope of the Eco-design Directive and the Energy Labelling Regulation.

32 https://www.eco-designworkingplan20-24.eu/

33 The study also looked at potential horizontal initiatives to implement, but for the purposes and scope of this study we focused on the approach used for products category screening.

Task 3 consisted of the following basic steps:

- **i. Scope, policy measures and tests standards:** Assessment of proposed scope, existing policy measures (if any) and availability of test standards
- **ii. Market:** Assessment of sales and stock data for EU27 for product types in scope and estimated development to 2030 and in some cases up to 2050. This is supplemented with a description of the present market, and anticipated development trends.
- **iii. Usage:** Description of typical usages and types of users. Data is collated for usage in terms of times, hours etc. per year.
- **iv. Technologies:** Description of typical technologies for BAU (Business As Usual), BAT (Best Available Technology) and BNAT (Best Not yet Available Technology). Data is presented for average intensity / efficiency, as far as data are available, and improvement opportunities.
- **v. Energy, materials, emissions and costs:** Where relevant and possible, calculation or estimation of impact on resources for design, use and end-of-life in BAU and life cycle cost (LCC). The LLC figures are for acquisition, use during the life of the product and end-of-life data for the users, the economy and including externalities. As an example for the assessment of professional laundry appliances, this section analysed:
    - Resources input use-phase and cleaning output
    - GHG emissions and NOx emissions of products in scope
    - Other possible environmental impacts related to the use of detergents and water use.
- **vi. Savings potential:** Estimation of energy savings (energy, resources, utilities costs, etc) and of economic feasibility. For lifetime extensions, this may be assessed per lifetime year taking into account a potential higher **in-use** consumption for lifetime extended products compared to the newer products on the market.

Following task 3, the 31 product groups were narrowed down to 16 product groups:

Product groups and horizontal initiatives	Primary energy savings PJ 2030		Selected for Task 4
	Use phase	Material content	
Product groups			
Professional laundry appliances	33		X
Professional dishwashers	20		X
Professional cooking appliances	117		X
Professional cooking products	39		
Low temperature emitters	170		X
Windows	70		
Water decalcifiers / softeners	20	20	
Swimming pool heaters	14-63		X
Aircurtains	2	1	
Non-tertiary coffee machines	6	8	
Tertiary hot beverage equipment	19	1	
Hair dryers	15	1	
Street lightning systems via PV	70		
Greenhouse covers	14-15		
Unmanned aircrafts (drones)			
Enterprise network equipment	22	3	X

Product groups and horizontal initiatives	Primary energy savings PJ 2030		Selected for Task 4
	Use phase	Material content	
Small network equipment for home and office use	69	7	X
Interconnected home audio and video	18	13	
Universal external power supplies		12-27	X
Universal batteries		19-45	
Product groups			
Uninterruptible power supplies	55	1	X
Electric vehicle chargers	11		
Base stations	30		
Industrial smart sensors	76-152	5	X
Horizontal Initiatives			
Lightweight design		180	X
Recycled content		160	X
Ecological profile			X
Durability		175-1052	X
Innovative IT solutions facilitating market surveillance			
Firmware and software			X
Scarce and critical raw materials			X

Table 7: Overview of the 31 products and initiatives from Task 3 showing primary energy savings in the use phase and related to the material savings (embedded in materials), harmonised to 10 years lifetime.
Blank cells: Not quantified or small potential.

These product groups were then further analysed in Task 4, which performed complementary analyses of the product groups to provide a more holistic picture of the products when including other environmental impacts; a view on existing regulations for same products; market surveillance impact; and industrial competitiveness.
As such, product ratings for the potential product groups were given on the basis of the suitability, feasibility for and positive impact of potential implementing measures and the related improvement of the environmental performance, as follows:

- +: Low positive impact
- ++: Medium positive impact
- +++: High positive impact

Product groups & horizontal initiatives	Primary energy savings PJ 2030			Resource efficiency	Other environ-mental impacts	Regulatory coverage and feasibility	Cost-effective-ness	Industrial competi-tiveness	Recom-menda-tions
	Use phase	Material content	Rate						
Product groups									
Professional laundry appliances and dishwashers	53		++	++	++	+++	+++	+++	+++
Professional cooking appliances	117		+++	+	++	++	++	++	++
Low temperature emitters	170		+++	+	+	++	++	+++	++
Swimming pool heaters	14-63		++	+	+	++	++	+++	+
Enterprise network equipment	22	3	+	+	+	++	+++	+++	+
Small network equipment for home and office use	69	7	++	+	+	+	++	++	++
Universal external power supplies		12-27	+	+++	+	+	++	+	++
Uninterruptible power supplies	55	1	++	+	+	++	++	++	+++
Industrial smart sensors	76-152	5	+++	++	+	++	++	++	+++
Horizontal Initiatives									
Lightweight design		180	+++	+++	+	++	+++	+++	++
Recycled content		160	+++	++	+	+	+	+	+
Ecological profile			+++	++	++	++	++	++	++
Durability and firmware		175-1052	+++	+++	+	+++	+++	+++	+++
Application software			+++	++	+	+	++	+++	+
Scarce and critical raw materials			+++	+++	+	++	+++	+++	+++

Table 8: Overview of the 15 products and initiatives recommended for the Working Plan.

More specifically, task 4 provided complementary analysis for the product groups regarding:

i. Further environmental impacts: Resource efficiency impact, where relevant, and other environmental impacts such as hazardous chemicals, other emissions and health.
   - consumption of materials and other resources such as fresh water
   - emissions to air, water and soil, including hazardous substances
   - possibility for reuse, recycling and recovery of material and/or of energy
   - consideration of the Critical Raw Materials (CRM) and other "scarce" materials used in the product and components, and an evaluation of the environmental and resource impacts, together with replacement / reuse/ recycling/ redesign improvement considerations
   - durability/repairability of the product
   - generation of waste

ii. Route to market: Assessment of possible involvement of craftsmen, architects, advisers etc. in the decision-making of selection of product or service to purchase.

iii. Existing regulatory coverage and regulatory feasibility: e.g. suitability for complementary policy measures; existing measures including third country legislation relevant for the product group and regulatory feasibility for Eco-design implementing measures and Energy Labelling delegated acts; legal feasibility etc.

iv. Cost-effectiveness of a potential regulation: Considered cost for potential implementing measures and recovery of the costs for the manufacturers and consumers in a life cycle cost perspective.

v. Industrial competitiveness (mainly qualitatively): e.g. Impact on competitiveness for EU manufacturers including specific impact on SMEs; impact on industrial innovation, etc.

Notably, although the study did integrate a range scoring criterion for products, in the conclusion, the study ultimately presented the product shortlist recommended as eligible for further attention in the EU's Working Plan, **underlining that the two main conditions followed for the final prioritisation of product categories** were **energy savings and/or resource efficiency potential and/or feasibility of implementation** (see tables below).

Ratings	Product groups/horizontal initiatives
+++: Highly recommended for the working plan due to higher saving potential and/or easier implementation.	Professional laundry appliances and dishwashers Uninterruptible power supplies Industrial smart sensors Durability and firmware Scarce and critical raw materials
++: Recommended for the working plan, however, with lowet saving potential and/or less easy implementation compared to +++.	Professional cooking appliances Low temperature emitters Small network equipment for home and office use Universal external power supplies Lightweight design Ecological profile
+: Recommended for the working plan, however, with lower rating due to lower saving potential, other issues related to the implementation and/or need for a pre-study.	Swimming pool heaters Enterprise network equipment Recycled content Application software

Table 9: Grouping of the products and initiatives according to ratings.

		Energy and/or resource efficiency potential		
		Low	Medium	High
Realisability	Complex	• Swimming pool heaters • Universal external power supplies	• Small network equipment for home and office use	• Ecological profile • Application software • Low temperature emitters • Lighweight design • Recycled content • Industrial smart sensors • Professional cooking appliances
	Smooth	• Enterprise network equipment	• Professional laundry appliances and dishwashers • Uninterruptible power supplies	• Enterprise network equipment

Table 10: Subdivision on low, medium and high energy and/or resources efficiency potential and complex and smooth realisability.

Some key examples of explanations for product categories put forward include:

- Universal external power supplies

"It is recommended to include the product group in the Working Plan for further assessments including refining the scope and developing implementing measures. There is a reasonable amount of **energy savings** related to resource efficiency and it is an area of interests for EU citizens who experience EPSs kept in stock but without any use. However, the type of implementing measure needs detailed studies."

- Professional laundry appliances and professional dishwashers

"Professional laundry appliances and dishwashers are a few products still in the category 'low hanging fruit': a preparatory study was done in 2011 and the products were found eligible in 2014, but robust test standards were lacking. The energy saving potential is reasonable and it is expected that the merging of the two product groups will reduce the resources needed for all parties involved."

9 Bibliography

ADEME, 2018. "Modélisation et évaluation des impacts environnementaux de produits de consommation et biens d'équipement"

"The Carbon Footprint of WEEE (Waste Electronic and Electrical Equipment) in the UK – a case study based on the UK's largest WEEE producer compliance scheme": https://eprints.lancs.ac.uk/id/eprint/169481/

Communication from the Commission Eco-design and Energy Labelling Working Plan 2022-2024 2022/C 182/01: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022XC0504%2801%29&qid=1651649049970

CE Waste – Key CRM Equipment. Accessed June 2022. https://cewaste.eu/wp-content/uploads/2021/04/210409_Cewaste_Table.pdf

Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of eco-design requirements for energy-related products: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009L0125

European Commission. "Sustainable Product Policy". Accessed 31 March 2022. https://joint-research-centre.ec.europa.eu/scientific-activities-z/sustainable-product-policy_en

European Commission. Eco-design Working Plan. Accessed June 2022. https://www.eco-designworkingplan20-24.eu/

European Commission. MEErP Revision. Accessed June 2022. https://susproc.jrc.ec.europa.eu/product-bureau//product-groups/521/project-plan

European Commission. "Establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC". Accessed June 2022. https://environment.ec.europa.eu/system/files/2022-03/COM_2022_142_1_EN_ACT_part1_v6.pdf

Halt Obsolescence website. Accessed June 2022. https://www.halteobsolescence.org/lindice-de-reparabilite-tient-ilses-promesses/

HM Government website. Accessed May 2022. https://www.gov.uk/government/statistical-data-sets/wasteelectrical-and-electronic-equipment-weee-in-the-uk

Ibec website. Accessed May 2022 https://www.ibec.ie/-/media/documents/connect-and-learn/industries/technology-and-telecoms/white-goods-association/wga-repair-data-survey.pdf

Les Numeriques website. Accessed May 2022. https://www.lesnumeriques.com/telephone-portable/comparatif-smartphones-telephones-portables-a407.html

Que Choisir website. Accessed July 2022. https://www.quechoisir.org/action-ufc-que-choisir-indice-de-reparabilitele-consommateur-bien-mal-eclaire-n96968/

Statistics Netherlands. Accessed May 2022. https://github.com/Statistics-Netherlands/ewaste

UK Energy-related Products Policy Study (Nov. 2021) https://etl.beis.gov.uk/erp-policy-study

UNU-KEY nomenclature is established within the EU regulatory framework, being used in the WEEE calculation tools (WCT) published by the European Commission:
https://environment.ec.europa.eu/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee/implementation-weee-directive_en Accessed May 2022

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