European Environmental Bureau

New EU eco-design proposals: Case studies to illustrate their potential impact

Final Report

November
2022

Cambridge Econometrics (Belgium)
Square de Meeus 35
1000 Brussels

info@camecon.com
www.camecon.com

The EEB is Europe's largest network of environmental citizens' organisations. We bring together over 170 civil society organisations from more than 35 European countries. Together, we work for a better future where people and nature thrive together.

Contact person: Jean-Pierre Schweitzer (European Environmental Bureau)
jean-pierre.schweitzer@eeb.org

Authors: Carl Heinemann (Camrbidge Econometrics) ch@camecon.com
Francisco Arsenio (Cambridge Econometrics) fa@camecon.com

Project director: Stijn Van Hummelen (Cambridge Econometrics) svh@camecon.com

The EEB is an International non-profit association / Association internationale sans but lucratif (AISBL).
EC register for interest representatives:
Identification number 06798511314-27
BCE identification number: 0415.814.848
RPM Tribunal de l'entreprise francophone de Bruxelles

European Environmental Bureau (EEB)
Rue des Deux Eglises 14-16
1000 Brussels, Belgium
+32 (0)2 289 1090
eeb@eeb.org
eeb.org
meta.eeb.org

With the support of the European Climate Foundation and the Life Programme of the European Union.

This publication reflects the authors' views and does not commit the donors.

Cambridge Econometrics' mission is to provide clear and useful insights, based on rigorous and independent economic analysis, to address the complex challenges facing society.
www.camecon.com

Cambridge Econometrics Limited is owned by a charitable body,
the Cambridge Trust for New Thinking in Economics.
www.neweconomicthinking.org

Contents

Key points

New EU Ecodesign proposals were published in March 2022

- In March 2022, the European Commission published new proposals to extend the scope of its Ecodesign regulations to all physical products on the EU market. Whilst the details still need to be worked out, future rules are likely to involve energy efficiency requirements, materials sustainability requirements, requirements regarding durability, repairability and recyclability, and enhanced information and transparency requirements for consumers and businesses through a digital product passport (DPP).
- The EU's own high-level estimates for the extended scope of Ecodesign rules point to a GHG emissions savings potential of at least 117 Mt CO_2eq per year.
- Our analysis shows that more environmentally friendly production of cotton t-shirts alone could contribute nearly 3% of that potential, the deployment of energy efficient microwaves and kettles could contribute another 4%, and innovations in concrete production could contribute at least 6%.
- The European Commission's impact assessment acknowledges increased costs for businesses to comply with new rules, which may be passed on to consumers in the form of higher product purchase prices. However, any extra costs to consumer are likely to be outweighed by the combined benefits of increased durability (less frequent replacement of products), efficiency (lower energy bills), and reduced environmental impacts. In addition, the measures could increase in economic activity for product repair and maintenance services, and the Commission expects a net increase in EU jobs as a result.
- The extended Ecodesign rules are likely to apply to a wide range of products. In this report, we develop four short, product-specific case studies to illustrate the impacts the future Ecodesign rules may have and what this means for consumers and businesses. The case studies cover textiles (T-shirts), kitchen appliance that are not in scope of the existing Ecodesign requirements (microwaves and kettles), construction materials (cement), and furniture (desks and chairs).

Textiles

- Market data suggests that around 3.3 billion t-shirts and similar tops are sold in the EU each year, most of which are made outside the EU. The vast majority of t-shirts use cotton or polyester as the primary fibre, and their production leads to an estimated 22 Mt CO_2eq of GHG emissions each year. Mandating a 30% reduction in the production emissions of cotton and polyester t-shirts (and similar tops) would save close to 6.7 Mt CO_2eq globally each year. Such a reduction could come from increased use of recycled materials, organic cotton cultivation, and the use of renewable energy sources.
- An increase in t-shirt durability by 10% as a result of Ecodesign rules is estimated to have potential savings of around 1 Mt CO_2eq each year from cotton and polyester t-shirts alone, if annual textile production for the EU market decreases accordingly.
- We estimate that almost 3 Mt CO_2eq of GHG emissions could be avoided each year if cotton production was made more sustainable, by using more

recycled cotton, renewable energy, and organic cultivation. This is equivalent to a third of Cyprus's yearly GHG emissions.

- We estimate that between 11 and 32 million brand new but unsold t-shirts and tops are currently destroyed or directly recycled in the EU market each year. If Ecodesign rules lead to the elimination of this overproduction, we estimate that over 12 million m^3 of water could be saved and demand for cotton reduced by 4 million kg each year.
- While textiles and clothing are highly diverse product classes, a small number of fibres accounts for a large share of the market. This means that horizontal Ecodesign measures could be targeted at the fibre level, to unlock such environmental benefits, in addition to addressing the millions of brand new but unsold items of clothing that end up being destroyed or recycled in the EU each year.

Small kitchen electronics

- We illustrate the potential benefits of Ecodesign rules for small kitchen appliances with an analysis of microwaves and electric kettles. We estimate that more than 15 million microwaves and more than 25 million electric kettles are sold across the EU each year, the production of which consumes over 100,000 tonnes of steel, over 700,000 m^3 of water, and causes an estimated 4.5 Mt CO_2eq in GHG emissions.
- Large-scale energy and resource savings could be achieved by requiring electronic appliances and devices to meet current best-in-class standards regarding efficiency and efficiencies: We estimate that over 9 TWh of electricity could be saved across the EU each year if all kettles and microwaves were replaced with more efficient models, as well as 27 million m^3 litres of drinking water. This would save an average household using one kettle and one microwave in the region of €26 per year in electricity and water bills.
- If future Ecodesign requirements led to greater durability of kettles and microwaves, we estimate that an increase in product lifetime of one year could save consumers around €450m each year as a result of less frequent replacement of these appliances, in addition to GHG emission savings of over 0.5 Mt CO_2eq due to lower production volumes.
- The potential impacts from regulating these two product types alone, gives a hint as to the large-scale environmental and consumer benefits that horizontal Ecodesign measures could deliver, which apply to all types smaller kitchen appliances (e.g., toasters, electric blenders, mixers, whisks, and coffee machines).

Cement

- Cement production is estimated to be responsible for around 7% of global CO_2eq emissions. The EU is self-sufficient in cement and has an annual cement production is in the region of 200 million tonnes each year, leading to GHG emissions of nearly 120 Mt CO_2eq. That's more than 3% of the EU's overall annual GHG emissions.
- Technology upgrades in cement production and the use of organic (renewable) fuels in clinker production, which requires high temperature kilns, could reduce annual emissions from cement production in the EU significantly. We estimate that 1.7 Mt of CO_2eq could be saved from replacing the remaining wet kilns with more efficient dry kilns in the EU, and another 7 Mt of CO_2eq could be saved from replacing 50% of the fossil fuels currently used in clinker production with more environmentally

friendly alternatives such as sludge or biomass. Combined, these two measures would save roughly the same as the annual GHG emissions of Cyprus. More ambitious options involving carbon capture and widespread use of renewable energy in production processes could save even more.

- Cement is not currently in scope of the proposed Ecodesign for Sustainable Products Regulations, but covered by the proposed revision of the Construction Products Regulation (CPR). Considering its vast environmental footprint, cement should be a priority for future regulations. The public sector could lead the way by introducing minimum sustainability requirements for cement used in public construction projects, considering that 40% of cement is used in public works.

Furniture

- We considered improvement options for office furniture and estimate that stricter Ecodesign requirements could unlock significant savings through mandating greater recycled material contents and reducing the overproduction of furniture.
- We estimate that EU sales of office chairs and office tables/desks are linked to GHG emissions of over 2 Mt CO_2eq each year – nearly the annual GHG emissions of Malta – and vast amounts of plastic and metal consumptions. Existing studies suggest that a 10% improvement in the carbon footprint of such furniture is achievable, for example by increasing the proportion of recycled metals, which would also allow for significant raw material savings.
- Considering that office chairs and tables are only a small fraction of the furniture market, the overall savings potential from horizontal and industry-wide measures around recycled material inputs is large. However, furniture products are extremely diverse, and therefore, horizontal measures would have to be carefully designed.
- A significant problem in the furniture industry is the disposal of brand new but unsold furniture. Figures from France suggest that across the EU, tens of thousands of brand new office chairs and desks are destroyed or sent to recycling each year, indicating a significant overproduction. Eradicating this overproduction could save another estimated 23,000 tonnes of CO_2eq each year across the EU furniture market.
- The public sector could lead the way by requiring minimum sustainability standards in the procurement of office furniture: If all EU public procurement of office tables/desks and office chairs were to choose products with increased recycled content and with an increased product durability of one year, this could save an estimated 56,000 tonnes of CO_2eq each year by lowering consumption of new aluminium, and save public institutions between 60-100 million euros each year as a result of less frequent replacements.

1 The new eco-design proposals

1.1 Overview of the proposed regulations

Key aims of the Ecodesign for Sustainable Products Regulation

The proposed Ecodesign for Sustainable Products Regulation (ESPR), published on 30 March 2022, establishes a framework for the improvement of the sustainability of products within the EU market. The proposed regulation is one of the key elements of the Circular Economy Action plan, which the European Commission adopted in 2020. The proposal features an extension of the current European Ecodesign Directive, which currently applies to energy related products only, to a much wider range of products.

The objectives of the proposed Sustainable Product Regulation are:

- To reduce the negative life cycle environmental impacts of products.
- To improve the sustainability of products.
- Allow for better access of information on sustainability along the supply chains.
- To incentivise more sustainable products and business models to improve value retention.

Specifically, the proposed regulations would entail the following interventions in the preferred implementation option:[1]

1. **Extension of the product scope of Ecodesign legislation to all physical goods.**
   Currently, only specifically selected products are covered in the Ecodesign legislation.
2. **Extension of sustainability requirements applicable to entire product groups.**
   This includes minimum product durability, recyclability, repairability and re-manufacturability; minimum recycled content; restrictions on substances that hinder recycling and reuse; and supply chain due diligence.
3. **Sustainability information for consumers and businesses**
   This would be achieved through the introduction of a Digital Product Passport (DPP), which includes information about durability, repairability, recyclability, recycled content, harmful substances, and the environmental footprint of a product. This might also include the development of sustainability performance classes.
4. **Reward more sustainable products through incentives.**
   This measure would require that member states link sustainability incentives to the environmental performance of products, where greater sustainability must be reflected in greater incentives for consumers or businesses to adopt a specific product.
5. **Measures for circular economy and value retention.**
   These measures include guidelines for supporting circular business

[1] See Impact Assessment: European Commission SWD(2022) 82. Available at: https://environment.ec.europa.eu/publications/proposal-ecodesign-sustainable-products-regulation_en - accessed 2 September 2022.

models, an EU-wide information hub, as well as a ban on the destruction of unsold goods and transparency requirements.

6. **Strengthened application of the Ecodesign framework.** This measure would improve the governance of Ecodesign through enhanced data collection from manufacturers of goods, knowledge sharing between national Market Surveillance Authorities, and reporting and benchmarking between member states.

The proposed ESPR regulation was published together with a new EU Strategy for Sustainable and Circular Textiles, as well as the announcement to revise the Construction Products Regulation (CPR).

The measures are not per se intended to reduce the overall consumption of goods and services. Instead, the proposed measures will operate at a product level, seeking to make the product more sustainable. However, it is plausible that as a result of increased product sustainability, the overall consumption of goods and services reduces. This could be the case, for example, where better product durability means less frequent replacement of products and therefore permanently lower annual sales.

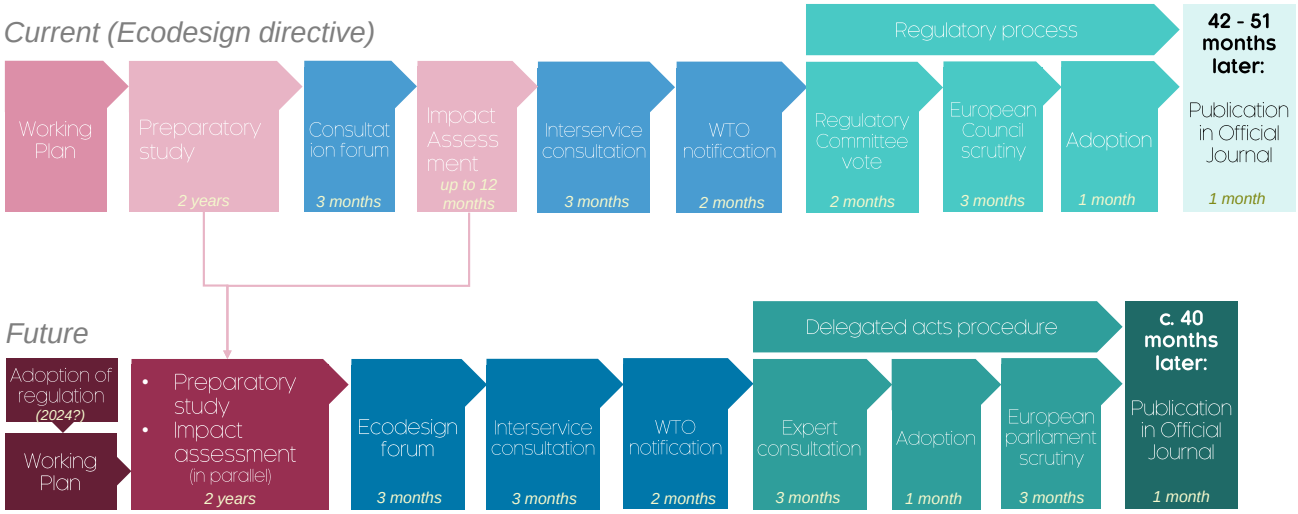
Implementing new measures will take several years

It is likely to take several years before new Ecodesign rules will come into effect as a result of the Commission proposal presented in March 2022. Under the existing Ecodesign regulation, the process to develop and implement regulation for one product group took roughly four years and involved the following sequence of actions: Development of a preparatory study (24 months), stakeholder consultation fora (3 months), impact assessment (3 months), interservice consultation within the European Commission (3 months), WTO notification (3 months), legislative process involving national parliaments, the European Parliament and the European Council (7 months), and finally the adoption and publication in the EU's Official Journal (EEB 2022). In the past there have been delays with this process, also because at the outset, product-specific proposed rules were being grouped into packages. As of 2021, only 25% of measures from the 2016-2019 work plan had been implemented (EEB, 2021).

The whole Ecodesign legislative process will be streamlined under the new proposal. The preparatory study and impact assessment will be merged, and 'delegated act' procedures will be used to adopt product-specific rules. Overall, this should reduce the time needed to implement measures by about a year, as shown in Figure 1.

Realistically, we think the first product-specific rules under the new proposals could take effect from late 2027 or early 2028, considering the time it takes to adopt the revised Ecodesign regulation, to develop and adopt product-specific delegated acts, and also considering a minimum grace period of 12 months for manufacturers to comply. Under the current framework, there have been significant delays in the implementation of product-specific measures (EEB, 2021). To avoid further environmental losses from delayed action, it will be important that under the future wider Ecodesign framework, the development and adoption of new measures is timely and well-managed.

Figure 1 Current and future legislative process for introducing eco-design product rules



1.2 Summary of the EU's own impact assessment of the regulations

The EU's impact assessment (IA) considers varying degrees of stringency for the interventions considered and estimates costs and benefits for the preferred options described above. Implementing the preferred set of regulations is expected to deliver significant net benefits.[2]

Environmental impacts

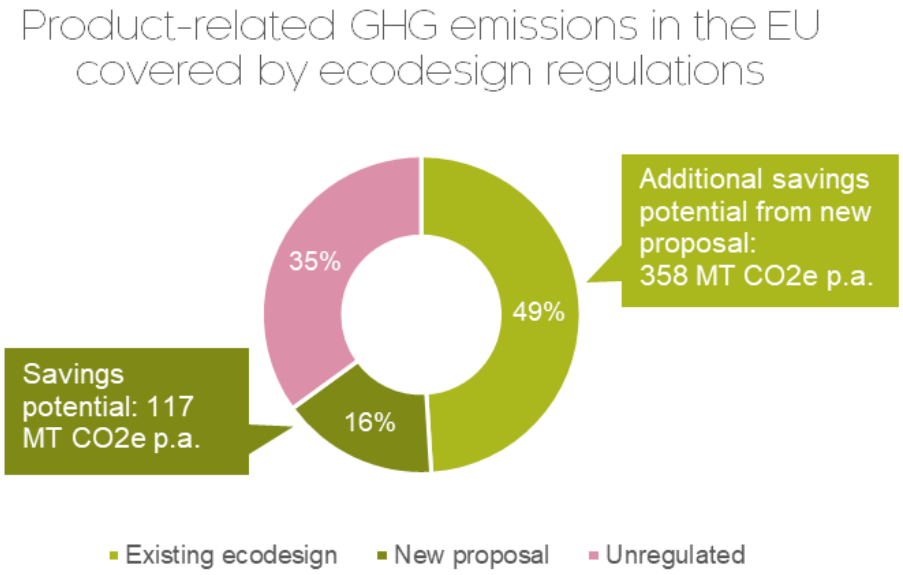
The Directive would lead to considerable GHG emission reductions over time

In the preferred set of options, the scope of the Ecodesign Directive would cover 65% of total GHG emissions from product consumption within the EU, 64% of particulate matter emissions, and 70% of resource depletion. Assuming an improvement of 15% GHG emission impact over the extension of the scope (this is assuming the same effectiveness in reducing GHG emissions as the currently existing Ecodesign Directive), the European Commission estimates that GHG emissions would reduce by 117 MT CO_2eq per annum. If the improvement of 15% is assumed to apply to the whole scope, i.e. a further 15% improvement also in those products that are already regulated, GHG emission would be reduced by 475 Mt CO_2eq per annum. In monetary terms, assuming a cost of carbon of 100 Euros per tonne of CO_2eq, these reductions in GHG emissions are equivalent to €12bn and €47bn per annum, respectively.

It is important to note that these values are crude estimates for the environmental benefits that future Ecodesign measures might potentially deliver, if fully implemented and covering all products within its scope, and assuming that the products in use have been fully substituted. The IA also points out that the realisation of the full benefits will take many years. For some products, full product substitution with Ecodesign compliant variants can take 30 years after new product-specific rules have taken effect, which itself will take several years after adoption of the new Ecodesign regulation as set out above.

[2] All figures quoted in this section are taken from: European Commission SWD(2022) 82

Figure 2 Ecodesign regulations' coverage of current product-related GHG emissions; potential GHG emission savings from new ecodesign proposal



Economic impacts

Implementation costs are expected to be offset by an increase in business revenues and consumer savings

Based on cost estimates for compliance with the existing Ecodesign legislation, the costs related to design and manufacturing changes in order to satisfy minimum requirements are estimated at €1-2bn per product group covered, or €30-60bn overall, if Ecodesign requirements are extended to 30 new product groups in the coming years. The European Commission expects these costs to be outweighed by increased business revenues and consumer savings, based on the impact accounting made for the current Ecodesign directive. Compliance with the DPP is expected to cost each company between c. €1,000 - €4,000 per product that is placed on the market, although it is unclear from the IA how this was calculated.

According to the European Commission, the current Ecodesign legislation has delivered significant economic benefits which outweigh its costs. Consumers have benefitted from large savings due to reduced expenditure on energy and consumables during product use, even if product acquisition costs are higher. It is uncertain to what extent the new proposals will still lead to consumer savings, as Ecodesign requirements are now extended to less energy consuming products. However, the new proposals would introduce rules around durability and recyclability, thus increasing product lifespans, meaning less frequent replacement of products for consumers. In addition, the recent energy price increases and higher inflation rates than over the past 15 years amplify the benefits to consumers of what may seem like relatively small energy and material savings.

The extension of product lifetimes is a key feature of the proposed new Ecodesign measures. As a consequence, annual product sales might decrease as products need to be replaced less frequently. Product purchasing costs for consumers and businesses may increase as businesses face higher costs to comply with the new rules, but there is also an increase in economic activity for product repair and maintenance. This is expected to have positive employment impacts in the EU, as repair and recycle activities tend to generate more jobs than incineration of obsolete products or transporting them to landfill sites (European Commission, 2022: p. 469). Increasing product

durability and recyclability also means that products have a higher value at the end of their lifetimes as they can be remanufactured, recycled, or harvested for components.

The European Commission expects negative impacts on SMEs due to increased admin burdens and compliance costs in the short run, but expects these to be offset by beneficial effects of the policies over time, e.g. through new business opportunities in repairing and recycling.

2 Case studies of the potential impact of the proposed regulations

To understand the potential impact of the proposed measures, we have developed short case studies for four product types which fall within the scope of the expanded Ecodesign regulations in the future. Case studies were selected based on availability of suitable life-cycle assessment studies and market information for sales and use of the products in the EU:

1 Textiles: Cotton shirts and t-shirts

2 Small kitchen electronics: Microwaves and electric kettles

3 Construction materials: Cement

4 Furniture: Office Chairs and office tables and desks

2.1 Methodological notes

The following case studies were developed on the basis of life-cycle assessment studies analysing the lifetime environmental impact and resource consumption of the relevant products, as well as information about average product usage and lifespan, and annual sales in the EU. All information was obtained via desk research, as well as analysis of resources provided by the European Environmental Bureau such as spreadsheet lists of known life-cycle studies.

Product life-cycle assessments are highly complex and results are sensitive to assumptions, such as the geography of production and consumption, input materials and energy sources during the production process, energy sources during the product use phase (for products that require energy), and assumption relating to disposal and/or recycling at the end of product lives. As a result, studies looking at similar products produce a range of results. For the illustrative case studies in this report, we aimed to collect several suitable data points and then took an average of the production (cradle-to-gate) GHG emissions and material consumption, as well as any use-phase environmental impacts reported in the studies, which we then used as a basis for our estimates.

Reliable information about annual product sales in the EU market has been challenging to obtain for single product types, such as microwaves and kettles, specific types of furniture (e.g., non-upholstered chairs), or specific textiles (e.g., t-shirts, as opposed to clothes in general). Our assumptions are informed by the information we have been able to obtain, and triangulation with related information, for example, the value of annual EU sales of one type of product and estimated average product prices can be used to estimate the number of products sold each year.

Product usage and lifespan data can be found online, but the source of the data reported online is often unknown and the information is therefore difficult to validate. We have generally aimed to find at least two sources on which to base our assumptions for a products' lifespan and/or frequency of use.

Throughout the case studies, we assume that in the baseline, annual product consumption and demand in the EU stays constant.

The impacts of the eco-design regulations considered in each of the case studies are:

1. Regulation of production process and materials, such as increased use of recycled materials, and/or the use of renewable energy in manufacturing, thus reducing the environmental footprint of product production
2. Regulation of energy consumption in products that require energy during use
3. Increased product life, as a result of greater durability and repairability
4. Changing business models to reduce unnecessary resource consumption, for example, optimisation of production volumes to reduce the number of unsold goods destroyed.[3]

2.2 Case study 1: Textiles

Overview of textiles consumption in the EU

In 2017, per capita consumption of textiles in the EU stood at 26 kg, corresponding to 11.6 million tonnes in aggregate each year (EEA 2019). This covers not only clothing, but also other textiles such as curtains, bed linen, towels and so on. The majority of the environmental impact of the EU's textiles consumption occurs outside of Europe where most textiles are manufactured, including 76% of the GHG emissions linked to textiles consumption (ibid.).

Globally, textiles production is an environmental damage hotspot. The UN Alliance for Sustainable Fashion estimates that the global textiles industry is responsible for between 2 and 8% of global GHG emissions, but these figures are highly uncertain.[4]

The European Commission's proposal would extend Ecodesign requirements to the textiles industry. In the Circular Economy Action Plan, textiles are the fourth highest priority product category in terms of raw materials use, and the fifth highest in terms of GHG emissions. Details of future Ecodesign requirements for textiles have not yet been decided, but it is likely that future regulations will address:

- The raw materials used in textile production, to improve circularity (e.g. by increasing the use of recycled content and by mandating the use of fibres and fibre blends that are easier to recycle), and to reduce the exposure of consumers to harmful substances.
- Transparency, through the digital product passport, to help households and businesses choose more sustainable, repairable and durable textiles.
- Transparency about the destruction of unsold textiles by textile retailers, with the aim to reduce overproduction and recycle unsold items.

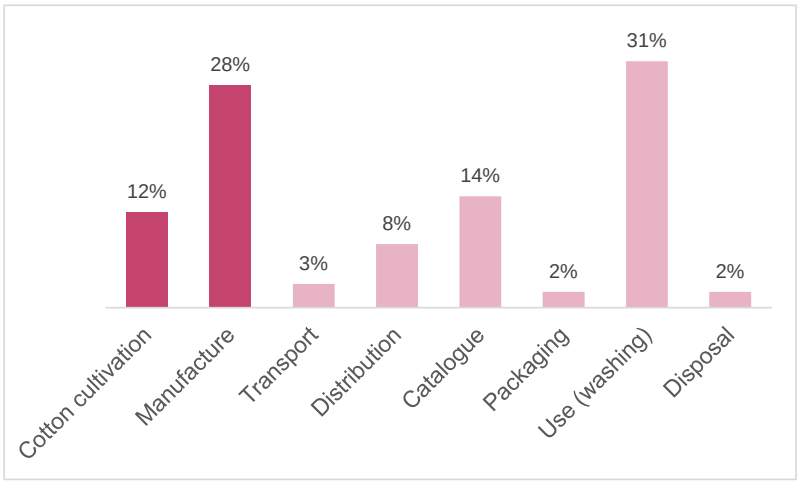
The life-cycle environmental footprint of cotton clothes is primarily concentrated in the production phase, but also during the use of the product

[3] Note that direct measures to reduce the volume of goods produced are not considered.

[4] See https://unfashionalliance.org/

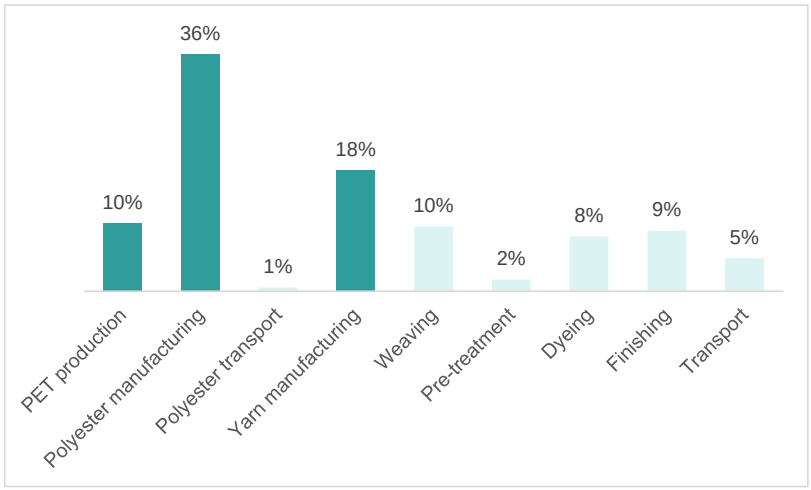
because of the environmental impact of washing (electricity consumption, water and chemicals use), as shown in Figure 4 below (Rana et al. 2015).

Figure 4 Lifecycle GHG emissions of long sleeve cotton shirts, by phase (Rana et al. 2015)



From an Ecodesign perspective, the cotton cultivation and manufacturing phase are most relevant, and these account for around 40% of the lifetime environmental footprint of cotton textiles. For polyester-based textiles, the fossil-fuel intensive production of PET and subsequent energy-intensive manufacturing of polyester fibre and yarn are likely to be key intervention points for Ecodesign measures. The production phase, and the subsequent distribution and logistics phases are also relevant if Ecodesign rules lead to longer product lives and hence reduce the number of items made each year.

Figure 3 Lifecycle GHG emissions of polyester sports t-shirts, by phase (Zequan, 2020)



Use-phase environmental impacts are related to washing and drying technologies used (washing machines and tumble dryers are already regulated by the existing energy labelling framework), and hence not directly determined by the product itself.

Environmental impact t-shirt consumption in the EU

Textiles are a very diverse product class. Considering available data, T-shirts were chosen as a representative product to illustrate the potential impact of the new Ecodesign proposals.

- Based on the market data available online, we estimate that each year, approximately 3.3 billion t-shirts and tops reach the EU market (EU28), or

an average of 6.4 items per capita. Assuming an average weight of 250g per item, t-shirts and tops would account for c. 6% of textiles consumption in the EU28, which we think is plausible.

- Of these 3.3 billion t-shirts and tops, we assume that one third (33%) are using cotton as the primary type of fibre, and 50% are using polyester, which is broadly in line with industry reports (Textile Exchange, 2021).
- Estimates for the life-cycle GHG emissions of imported cotton t-shirts range from c. 4kg to 9kg CO_2eq. One estimate for long-sleeve cotton shirts puts lifetime GHG emissions at 10kg CO_2eq, of which 67% occur before the use phase (i.e. during manufacturing and shipment to retailers) (Rana et al. 2015). One study of organic cotton t-shirts has estimated cradle-to-gate emissions at 5.4kg CO_2eq (Nagel 2010). The remainder of emissions is concentrated in the use-phase due to washing and tumble drying. Given the range of life-cycle GHG emissions estimates, we assume that the representative cotton t-shirt emits 7.1 kg CO_2eq throughout its life-cycle, of which 4.7 kg CO_2eq are related to production and supply.
- Estimates for the production phase GHG emissions of imported polyester t-shirts range from 5kg CO_2eq (ADEME, 2018) to 14.1kg (Kalliala & Nousiainen, 1999). For this case study, we use values in the middle of that range from the most recent identified paper (Zequan, 2020), which reports a cradle-to-gate GHG emissions and water use of 10.6kg CO_2eq and 379 litres per T-shirt.
- We estimate that GHG emissions from the production of cotton and polyester t-shirts sold in the EU each year is in the region of 22.5 Mt CO_2eq – this is more than Croatia's annual GHG emissions. In addition, an estimated 3.5 billion m^3 of water, 1.2 million tonnes of raw cotton, and over 190 million litres of crude oil (as raw material for PET production) are consumed each year for the production of said t-shirts.
- The average number of wears of a cotton t-shirt has been estimated between 45 days (SAC, 2021) and 50 days (JRC, 2006). We assume 50 wears for the analysis presented below, as this implies a slightly slower pace of product substitution and is therefore the more conservative figure to use in our estimate of the environmental impact of an increased product life. For polyester t-shirts we assume 95 wears (JRC, 2006).
- Options to improve the environmental footprint of t-shirts identified in the literature include the use of organic cotton, recycled cotton, and/or renewable energy in production. These options reduce production-phase emissions by 47% to 70% (Kazan et al., 2020). It is unlikely that these options could be implemented for the whole t-shirt market, but the European Commission may require a specific reduction in production-related GHG emissions and material consumption, and let manufacturers decide how this is achieved.

Ecodesign measures could reduce the impact of t-shirt consumption

We estimate that a mandatory 30% reduction in the cradle-to-gate GHG emissions of cotton and polyester t-shirts on the EU market alone, regardless of how this might be achieved, could save 6.7 Mt of CO_2eq each year globally – approximately two thirds of Luxembourg's annual GHG emissions.

Another impact of future Ecodesign rules could be around product durability. Whilst there is great uncertainty about how this could affect clothing markets, we provide an illustration of the potential benefits.

Details of the future Ecodesign requirements for textiles are still unknown, and therefore the following scenarios are illustrative only, to give a sense of the potential impacts.

Improved production processes

Ecodesign rules could impose a generalised requirement to improve the environmental footprint of certain textiles by a specific percentage, for example a 30% reduction in the production-related carbon footprint of clothes. Using figures from LCA studies, we calculate the potential material and resource savings for the hypothetical scenario that to comply with such as generalised target, 50% of cotton t-shirt manufacturing switches to using renewable energy and organic cotton cultivation, and the other 50% switch to using recycled cotton instead of newly cultivated cotton. Producing half of all t-shirts sold in the EU each year with recycled cotton could reduce demand for virgin cotton by 600,000 tonnes a year, and save 560 million m^3 of water. In this scenario, GHG emissions from cotton t-shirt production would reduce substantially, with a combined total saving of 3 Mt CO_2eq in GHG emissions (an amount equivalent to burning approximately 1.1 billion litres of diesel).

For polyester-based t-shirts, a 15% improvement in GHG emissions would amount to 2.6 Mt CO_2eq in GHG emission savings – these could be achieve through improved energy efficiency in the production process, especially in manufacturing polyester from raw PET, and manufacturing yarn from polyester fibres, which are energy intensive processes. Another option reported in the literature is the use of recycled PET, for example from bottles and other food containers, instead of virgin PET. However, this is seen as problematic, because once PET plastics is turned into polyester fibres, these are much more difficult to recycle and lead to increased release of microplastics. In fact, it is preferable to re-use PET plastics in direct PET applications, such as bottles and other PET packaging which allows for a closed loop to be maintained (Changing Markets, 2021).

Increased durability of textiles

In addition to improved environmental performance in manufacturing, Ecodesign rules could lead to greater durability of t-shirts. If the useful life to t-shirts increased by 10% (that's around five extra wears for cotton t-shirts, and around ten extra wears for polyester t-shirts), far fewer t-shirts would need replacing each year, and as a result overall production volumes could be reduced. In reality, many clothes are not worn until they are unusable, but may be disposed of when they are no longer liked. If that longer lifespan is realised for only 50% of t-shirts, we estimate that this could save close to 160 million m^3 of water, 57,000 tonnes of cotton, and 9 million litres of crude oil, as well as 1 Mt of CO_2eq emissions each year from reduced production, based on current production methods. These potential emission savings are as much as burning 400 million litres of diesel.

Eliminating the overproduction of textiles

A significant share of new clothes remain unsold in the EU each year. In France, an estimated 9% of all clothes remain unsold, and in the Netherlands 6%. Most unsold clothes are donated or sold to specialised outlets or wholesalers, but they may ultimately still be destroyed. Between 5.8% (Netherlands) and 11% (France) of unsold clothes are directly destroyed or recycled (Kort et al. 2020; ADEME et al. 2021).

Assuming that the EU-wide figures for unsold and destroyed t-shirts lie within this range, we estimate that between 11 and 32 million new t-shirts are destroyed or directly recycled in the EU each year. If Ecodesign measures successfully eliminated this underlying overproduction of t-shirts, this could

save vast amounts of resources, water and energy. Eliminating the overproduction of cotton and polyester t-shirts in the EU market alone could save between 12 to 35 million m^3 of water, between 4,300 to 12,300 tonnes of cotton, and 0.7 to 1.9 million litres of oil due to lower PET production each year, based on t-shirt production input data from Kazan (2020) and the European Parliament (2020). This would also avoid production-related GHG emissions in the range of 80,000 to 220,000 tonnes CO_2eq per year.

Looking at the whole textiles sector and assuming the destruction or direct disposal of unsold goods is homogeneously distributed across product types in the EU, we estimate that between 1.2 Mt and 3.3 Mt CO_2eq could be saved across the whole industry by tackling overproduction, based on GHG emissions data from the European Environmental Agency (2019). For comparison, Malta's annual GHG emissions are in the region of 2 to 3 Mt CO_2eq a year.

2.3 Case study 2: Small electric kitchen appliances

Overview of small electric kitchen appliances in the EU

The current Ecodesign regulations only apply to large and energy intensive electric kitchen appliances such as fridges, freezers, ovens and dishwashers. Kettles were considered for Ecodesign or energy labelling measures, but following the presentation of the preparatory in January 2021 the Commission decided not to implement any measures. As regulating small appliances individually is burdensome and delivers only relatively small benefits for each type of product, it makes sense for the new Ecodesign proposals to introduce horizontal measures covering whole groups of small kitchen appliance – and the sum of individual product types would also generate significant savings. Given the availability of data, we selected electric kettles and microwaves for case study analysis to illustrate the potential impact if Ecodesign and energy labelling measures were applied to small electric kitchen appliances.

Future Ecodesign measures for small appliances are likely to include:

- Enhanced product efficiency during its use phase (electricity and water efficiency for example)
- Enhanced product repairability (increasing lifetime) and recyclability
- Regulation of materials used in production (preventing the use of harmful softeners in plastics, e.g.), and increasing the recycled content e.g. in the casing of appliances.

EU consumption of kettles and microwaves and their impact

We estimate that roughly 18 million units of microwaves and 26 million electric kettles are sold each year in the EU, based on reports and research reporting the estimated stock of microwaves and kettles in the EU and their life expectancy (own calculations, excluding the UK, based on Gallego-Schmid et al. (2018b); Gallego-Schmid et al. (2018a)).

According to Gallego-Schmid et al. (2018b), the lifecycle global warming potential impact of a typical electric kettle is approximately 400kg CO_2eq. The paper also reports the lifecycle impact of an environmentally friendly designed kettle at 268kg CO_2eq. These lower emissions are a consequence of increased temperature control and water and energy efficiency, which also lead to lower water and electricity consumption; with savings of 239 litres of water and 67.5 kWh of electricity, respectively per year for each replaced kettle.

Regarding microwaves, research by Gallego-Schmid et al. (2018a) points towards a lifecycle environmental footprint of an average microwave of 416 kg CO_2eq. A study by the European Commission (2011) has estimated that there is an improvement potential of reducing the lifetime GHG emissions of microwaves by 14%. These lower emissions are a consequence of a more energy efficient microwave design that uses less energy when in use. Based on data from the later report, best-in-class microwaves use 8% less energy (5.4 kWh per year) when compared to an average design.

We estimate that through their electricity consumption, the stock of kettles and microwaves in use in the EU causes emissions in the region of 13Mt CO_2eq each year. The production of new kettles and microwaves sold in the EU each year uses an estimated 138,000 tonnes of steel, 732,000 m^3 of water, and leads to GHG emissions of 4.5 Mt CO_2eq.

Future Ecodesign requirements for small kitchen appliances are likely to focus on energy and material consumption during production and use-phase, but also on product durability and overproduction.

Improved energy efficiency

If Ecodesign measures applied energy consumption limits to all microwaves and electric kettles, based on the best performing devices currently on the market (as far as identified in our desk research), significant material and energy savings could be achieved. In this framework, the stock of current 'baseline' appliances is replaced over time and at the rate of annual product sales by Ecodesign-compliant versions. In the long run, this entails a yearly emission savings of roughly 1 Mt CO_2eq from more efficient microwaves and yearly savings of around 3.5 Mt CO_2eq from more efficient kettles. Assuming regulations take effect from 2028, we estimate that by 2030, 6 Mt CO_2eq will have been saved cumulatively as a result of more eco-friendly variants entering households, compared to a baseline where there are now energy efficiency improvements. However, (nearly) full substitution of the stock of kettles and microwaves with more eco-friendly versions will take at least eight years.

Reducing the overproduction of kitchen appliances

Ecodesign requirements could ban or reduce the destruction or disposal of new unsold kitchen appliances. Data for France suggests that 1.3% of all kitchen appliances on the EU market remain unsold each year, of which 42% are destroyed or recycled (ADEME 2021). Eliminating the current overproduction of such appliances for the EU market leads to a reduction of around 98,000 microwaves and 140,000 kettles needed every year, resulting in combined savings of roughly 25,000 tonnes of CO_2eq per year (assuming current product design, and not improved variants).

This would also lead to material savings. Reducing the overproduction of microwaves could save approximately 690 tonnes of steel, 110 tonnes of glass and 2 million litres of water per year. For kettles, we estimate that 64 tonnes of steel, 64 tonnes of polypropylene, and also around 2 million litres of water could be saved each year. These estimates are based on the material composition data of microwaves and kettles found on Gallego-Schmid et al. (2018a) and Gallego-Schmid et al. (2018b), respectively.

Greater product durability

Another aim of the Ecodesign regulations is to increase the durability of products, by ensuring products are well-made and easy to repair. The lifetime of an average microwave is estimated to be 7.5 years, and that of an average kettle to be 4.4 years. If microwaves and kettles were to last longer than currently, a lower number of microwaves would need to be sold each year, in order to maintain the current stock of microwaves or kettles in the EU market. We estimate that the increased durability of one year for both microwaves and electric kettles (the more eco-friendly variant mentioned above) would reduce annual EU sales of microwaves by around 2 million units (EU28), and that of kettles by 4.9 million units (EU27).

Reducing annual production volumes accordingly, roughly 670,000 tonnes CO_2eq could be saved globally each year, as well as 17,000 tonnes of steel, 2,000 tonnes of both glass and plastics, and over 100 million litres of water. In addition, an increased durability of one year for kettles and microwaves could save EU consumers around €450m each year, assuming a price of 120€ for an average microwave oven, and €40 for an average kettle.

Combining the analysis presented above (assuming that all product are 1 year more durable, have the greater energy performance mentioned above

products, and overproduction is eliminated), we estimate a total savings potential of around 6.5 Mt CO_2eq per year – this is more than two times Malta's annual GHG emissions.

Water and electricity savings

Environmentally friendly kettle designs also deliver water and electricity savings during use. Gallego-Schmid et al. (2018b) estimate that improved kettles could decrease water and electricity consumption by 239 litres and 67.5 KW/h, respectively, in each year of use, compared to a regular design.

Based on these values, we estimate that around 27.5 million m^3 litres of water and 7.5 TWh of electricity could be saved across the EU each year, assuming that the whole fleet of kettles is substituted by improved variants. An average household with a single kettle could save around 21 € in electricity bills, and 1 € in water bills yearly. Replacing the whole stock of kettles in the EU with the improved design could save consumers 2.5 billion € per year in water and electricity bills, assuming August 2022 electricity prices.[5]

The same applies to microwaves: a more efficient variant could save an average household 16 kWh of electricity per year, which corresponds to 4.88 € per year (August 2022 prices). Aggregating this to the EU level, we estimate that the replacement of the whole stock of microwaves with the improved design could save consumers roughly €650 million in electricity bills each year, or roughly 2 TWh of electricity.

[5] For this calculation, we used the 2020 water price in the UK, which is roughly situated in the middle of the range of prices in European countries, as reported at: https://smartwatermagazine.com/news/locken/water-ranking-europe-2020 ; and the August 2022 average electricity price across the EU27, as reported at: https://www.energypriceindex.com/price-data

2.4 Case study 3: Cement

Cement is the most widely used construction material worldwide and it is also one of the most polluting industries in terms of GHG emissions given the energy intensity of its production process. Cement is responsible for 7% of global emissions (IEA 2018). According to the International Energy Agency, the sector is the second largest industrial emitter of CO_2 and the third largest energy consumer (IEA 2018).

Environmental impact of current EU cement production

In the European Union, it is estimated that the yearly GHG emissions associated with cement production are between 114 Mt (Enkvist et al. 2018) and 120 Mt CO_2eq (Emele et al. 2022) – roughly equivalent to the annual GHG emissions of Belgium. The calculations below use the average of these two estimates, at 117 Mt CO_2eq. According to Eurostat's Prodcom database, 196 million tonnes of cement were produced in the EU28 in 2019.

We estimate the environmental footprint of EU cement production to be 0.6 kg of CO_2eq on average per kg of cement. This is within the range reported in the LCA literature, ranging from 0.5 to 0.9kg of CO_2eq per kg of cement produced (Fayomi 2019). The figure used in our calculations is closer to the lower end the range, considering that cement manufacturing is becoming more efficient as wet kilns are gradually phased out.

Construction materials are identified as a priority in the Circular Economy Action Plan (CEAP) and are also included under other EU initiatives such as the Strategy for a Sustainable Built Environment. Future requirements for the environmental footprint of cement production could be set by the new Ecodesign regulations, or under the revised Construction Products Regulation (CPR). The existing CPR rules are mainly about increased information, transparency and standardisation, rather than performance requirements for products. It is plausible, that products such as cement could be regulated in the same way as the future Ecodesign framework will regulate products. A key aspect of this could be a legal cap on the GHG emissions footprint of cement, based on a uniform environmental footprinting methodology established by the European Commission, and sustainability requirements for public procurement of construction materials. This could accelerate the deployment of low carbon cement production.

To illustrate the impact of future environmental regulation of European cement production, we discuss three improvement options identified in the literature that could be used to comply with GHG emission limits.

Phasing out wet kilns

Replacing the remaining wet kilns with modern dry kilns would significantly cut the GHG emissions per ton of cement of producers who still operate wet kilns. Wet kilns reportedly still account for approximately 10% of cement kilns in the EU (Cembureau 2021) and use much more energy than dry kilns (Sridharan 2020). In this context, replacing kilns with their more efficient variants reduces life-cycle GHG emissions by 10% (Sridharan 2020). Based on these assumptions, we estimate that phasing out the last wet kilns would reduce GHG emissions from EU cement production by 1.7 Mt CO_2eq each year, approximately 1.5% of total emissions from cement production in the EU, and similar to burning 600 million litres of diesel. It should be noted that the industry is likely to phase out wet kilns over time regardless of any future regulations, given their higher energy needs. However, there may still be a role for Ecodesign measures to accelerate the speed of that transition.

More widespread use of alternative fuels

On top of that, replacing traditional fossil fuels (coal, natural gas and fuel oil) used in clinker production, which involves high temperature processing, with more sustainable alternatives, such as sludge, waste oil, or biomass, could cut GHG emissions by 12% (Sridharan, 2020). The adoption of alternative fuels is already well underway in European cement production and was probably accounts for around half of the industry's fuel use (46% back in 2017, according to EEIP 2022). Using such alternative fuels in the remaining 50% of EU clinker production could reduce annual GHG emissions by 7 Mt CO_2eq each year, or around 6% of total emissions from EU cement production.

Renewable energy use and carbon capture

More ambitious changes to production processes in response to Ecodesign requirements could involve the use of renewable energy and carbon capture and storage. The combination of renewable energy in production and carbon capture of the remaining emissions are estimated to decrease GHG emissions by 48% per kg of cement produced (Sridharan, 2020). If 50% of EU cement production adopted such improvements, this could reduce GHG emissions by 28 Mt CO_2eq – a quarter of the industry's current total emissions, and roughly equal to Slovakia's annual carbon footprint.

Other options to improve the environmental performance of cement production include measures that reduce the clinker-to-cement ration, for example, by addressing overspecification. Industry analysis suggests that for each percentage point reduction in the share of clinker, 8 to 9 tonnes of CO_2 be saved per tonne of cement (GPC, 2019). Future Ecodesign measures could seek to reduce the average clinker-to-cement ratio in the EU, for example by setting a cap on the average carbon footprint of cement used in the EU.

A large share of construction industry work requiring cement is carried out for public sector clients, for example, infrastructure such as bridges and roads, hospitals, and schools. In a recent report, the United Nations Industrial Development Organisation assumes that public projects account for 40% of all cement use (UNIDO, 2021). If public procurement rules required certified low-carbon cement, this could significantly advance industry decarbonisation. Ecodesign measures could also apply to waste recycling in the European cement industry, which uses large amounts of limestone and clay.

As mentioned above, future Ecodesign rules are unlikely to come in before 2028 – considering the significant savings potential in the cement production, the industry should be a priority for future environmental regulation.

2.5 Case study 4: Furniture

The European Union is a major furniture producer and net exporter of furniture. European furniture accounts for over a quarter of global production (EEB 2017). Germany, Italy, Poland, and France are the biggest furniture producers in the EU and account for around 13% of the world's production of furniture alone (CEPS 2014). Most of European produced furniture is consumed inside the common market. Overall consumption of furniture is about 10.5 million tonnes per year in the EU27 and the UK.

Future Ecodesign regulations for furniture could address:

- Enhanced durability and repairability in order to increase product lifespan and reduce waste;
- Regulation of materials used in the production process, such as mandatory recycled material content, with the goal of decreasing its environmental impact;
- Increased recyclability of used products.

The furniture sector is very diverse, with a multitude of varying product types, and this report focuses on a small selection of representative products, where the available data allowed for the development of estimates. These products are office tables/desks and office (swivel) chairs.

Environmental impact of EU office furniture consumption

For office desks, we assume an average global warming potential of around 165kg CO_2eq, based on four data points (Spitzley et al. 2006, Dietz 2005, ADEME 2018). We consider this to be representative for all office tables in the EU for our estimate. We further assume a representative lifespan for desks of 15 years.

Based on existing studies, we assume a lifecycle carbon footprint of office chairs of around 93kg CO_2eq, predominantly linked to their production and distribution (Dietz 2005, Spitzley et al. 2006; Furniture Industry Research Association 2011). We further assume a useful life of 10 years for office chairs (Edwards & Hill Office Furniture, 2020), and assume that the figures reported are representative for all office chairs in the EU.

We assume EU-wide sales of 6.3m office desks and tables, and 11.9m office chairs per year, but these figures are highly uncertain and based on indicative product lifetimes and estimates of the number of office workers in the European Union. Our indicative estimate for the production-related GHG emissions of all office chairs and office desks/tables sold in the EU market each year is in the region of 2.1 Mt CO_2eq – roughly equal to the annual GHG emissions of Malta.

Ecodesign rules could require manufacturers to apply carbon footprinting methodologies to existing furniture products, and achieve a specific reduction in GHG emissions over time, for individual products or across a manufacturer's product portfolio.

Reducing the environmental footprint of office furniture

This could be achieved through improved product design or more efficient production processes. Various options are identified in the academic literature, such as increasing recycled content (recycled metals in particular), greater process efficiency during production (e.g. for furniture products that involve leather), and lowering the content of resin in particle board used in desks and tables (Spitzley et al., 2006).

It is important to note that given the great diversity of furniture products, with many different material compositions possible within each class of product (e.g. tables can be made from wood, plastic, metal, or combinations of these), environmental footprints and improvement options are highly context-specific.

Reported improvements in GHG emissions are in the region of 13% for desks and tables, and 8% for office chairs, when efficiency measures are combined (Spitzley et al., 2006). Substituting new (primary) metals with recycled metals can have a particularly large impact on product environmental footprint: the Aluminium Association estimates recycled aluminium has a 94% lower GHG emissions footprint than primary aluminium, with GHG emissions savings of roughly 8kg per kg of aluminium (Aluminium Association, 2022).

A possible scenario could be a 10% reduction in the production-related GHG emissions footprint of furniture products, mandated by Ecodesign rules. We estimate that this could save in the region of 0.2 Mt CO_2eq globally each year.

If this is achieved through increased recycled content, this would also lead to raw significant material savings. One study analysing an American office swivel chair concludes that per chair, c. 15kg of steel, over 6kg of plastic, and 6kg of non-ferrous metals (mainly aluminium) are used (Spitzley et al., 2006).[6] The same study reports 23kg of steel, 15kg of particle board, and 12kg of aluminium use for a mainstream height adjustable office desk.

There is a great diversity in the material composition of office chairs and many producers may already use recycled metal inputs, for example. However, these figures give an idea of the material savings that may be possible. Assuming that in each office chair and each desk sold in the EU each year, only 1kg of primary aluminium is replaced with 1kg of recycled aluminium would save 18,000 tonnes of primary aluminium each year – and this alone could save emissions of 0.1 Mt CO_2eq or more.

Overproduction linked to unsold furniture

A portion of all furniture on the European Union market remains unsold after each year. Data for France suggests that 2.3% of all furniture on the French market is not sold, of which 46% is directly destroyed or ‘recycled’ (ADEME 2021). Based on these figures, we estimate that around 70,000 brand new office desks and tables, and 130,000 brand new office chairs are disposed of in the EU each year. Taking measures to mitigate this overproduction for these two product types alone could reduce yearly GHG emissions by nearly 23,000 tonnes of CO_2eq, and save significant amounts of raw materials.

Extended lifetimes of office furniture

Future Ecodesign requirements for product durability and repairability could extend product lifetimes. As a result, products will need to be replaced less frequently, leading to consumer savings, as well as lower raw material use and GHG emissions due to lower annual production volumes.

Illustrative estimates show that a one year extension of the useful life of office desks and tables, from 15 to 16 years, could save 65,000 tonnes of CO_2eq each year, and 100,000 tonnes CO_2eq could be saved if office chairs lasted 11 years instead of 10 years. Combined, this is as much as burning over 60 million litres of diesel.

[6] These figures seem high, at least in a European content. We estimate an average office chair weighs in the region of 10 to 15kg. We therefore only provide illustrative estimates for the amount of raw materials that could be saved.

Public sector procurement of office furniture

Future Ecodesign legislation might apply stricter rules to public sector procurement and require public sector buyers to choose products that meet certain minimum standards. Based on OECD figures for public procurement, we assume that 14.9% of all office furniture sales are in the public sector.[7]

We estimate that switching all public procurement of office desks and chairs from current regular products to more eco-friendly and durable variants (increased durability of one year, and environmental improvements as suggested by Spitzley et al. (2006) [8]) could save an 56,000 tonnes of CO_2eq each year – as much as burning 21 million litres of diesel.

Assuming unchanged product prices, increased durability of office chairs, desks and tables could save public institutions across the EU between 60-100 million euros each year as a result of less frequent replacements. Savings would be higher if eco-friendly procurement were applied to all public sector furniture purchases.

There is significant potential for environmental benefits from regulating furniture products in the EU. However, as mentioned above, new rules are unlikely to come in before 2028, and that full potentially savings, especially those from greater product durability, would take at least a decade to materialise.

[7] According to the OECD, public sector procurement in the EU accounted for 14.9% of GDP in 2020 (OECD 2021).

[8] Desks: Doubling the content of recycled aluminium for extruded aluminium components, reducing the use of resin; Office chairs: increasing the amount of recycled content in cast aluminium parts to 99%.

3 Conclusions

The European Commission plans to introduce Ecodesign measures covering all physical products, to make products more durable and recyclable, and improve material use and production methods to reduce the environmental footprint of the consumption of goods in the EU. This will lead to greater circularity, lower resource consumption, reduced GHG emissions and also consumer savings.

The introduction of digital product passports, one of the landmark features of the Commission proposals, would also make it easier to introduce horizontal measures in the future that cut across individual product types, such as a flat target for GHG emissions reductions for a wide product group, or across a manufacturer's product portfolio.

Details are still unknown and it is unlikely that new product-specific measures could come into effect before 2028. However, the EU's own impact assessment suggests that in the long run the new rules could deliver savings of at least 117 Mt CO_2eq, on top of resource and consumer savings, and lead to additional jobs in the EU as a result of a growing recycle and repair economy.

The case studies presented how the environmental footprint of different product groups, that are not yet regulated, could be addressed under the wider Ecodesign regulations. Our analysis shows vast benefits for the environment and for consumers:

- The textiles industry is a major source of global GHG emissions and resource consumption – water in particular. Reducing the environmental footprint of the 3.3bn t-shirts and tops sold in the EU each year by mandating cleaner production processes and greater use of recycled materials has a huge savings potential. If 50% of cotton t-shirts on the EU market were made using recycled cotton, this would save 560m m^3 of water, and avoid 600,000 tonnes of virgin cotton cultivation. Likewise, making t-shirts last 10% longer than they currently do can unlock large-scale resource savings: a 10% longer lifetime of polyester t-shirts on the EU market could save 9m litres of crude oil each year if that greater durability is realised by 50% of wearers.
- Whilst final products are relatively diverse, there is a small number of fibres that dominate the market – in the case of t-shirts, these is polyester and cotton fibres. We estimate that a 30% reduction of GHG emissions from the production of cotton and polyester t-shirts sold in the EU alone would result in a yearly emissions reduction of 6.7 Mt CO_2eq equivalent. For textiles, horizontal Ecodesign measures could therefore be targeted at the fibre level, to unlock such environmental benefits, in addition to addressing the millions of brand new but unsold items of clothing that end up being destroyed or recycled in the EU each year.
- At an individual level, small kitchen appliances don't use a huge amount of resources when they are manufactured and use only little energy during use. But considering the range of small appliances that exist in modern kitchens (electric blenders and mixers, whisks, toasters etc.), there are significant environmental benefits to be had. Our figures show that

switching to more eco-friendly microwave and kettle designs alone can save in the region of 6.5 Mt of CO_2eq each year, in addition to household utility bill savings. These are relatively large and energy consuming types of 'small' kitchen appliances, but it is not unreasonable to think that this figure could increase by another 50% if similar improvements were made in the other appliances listed.

- EU cement production accounts for roughly 3% of EU territorial GHG emissions, and should be a priority for future environmental regulation. Our research shows that significant savings are possible if production processes are improved and modernised: for example, using alternative fuels such as biomass and sludge more could save 7 Mt CO_2eq p.a. – that's more than two thirds of Luxembourg's annual GHG emissions.
- Ecodesign measures in the furniture industry could also lead to significant emissions and materials savings, by increasing the use of recycled materials and improving product durability. Furniture products are extremely diverse, and therefore, horizontal measures would have to be carefully designed. Improvements to office chairs and office tables could save in the region of 0.2 Mt CO_2eq per annum, as well as thousands of kilos of metals. These two product types only is only a fraction of the furniture market – perhaps 5% – so this provides an indication of the total potential. The public sector could lead the way, if public procurement rules required certain environmental standards for new purchases of office furniture, such as minimum content of recycled materials.

4 References

ADEME (2018). LCA modeling and evaluation of consumer products and capital goods. Data table. Available at: https://bilans-ges.ademe.fr/documentation/UPLOAD_DOC_EN/index.htm?electromenager.htm – accessed 18 August 2022.

ADEME, In Extenso Innovation Croissance, Phenix, Crédoc (2021). Etude des gisements et causes des invendus non alimentaires et de leurs voies d'écoulement. 158 pages. Available at : https://librairie.ademe.fr/dechets-economie-circulaire/5035-etude-des-gisements-et-des-causes-des-invendus-non-alimentaires-et-de-leurs-voies-d-ecoulement.html - accessed 12 September 2022.

Aluminium Association (2022). Aluminum Carbon Footprint Cut in Half Over 30 Years. Article. Available at: https://www.aluminum.org/aluminum-carbon-footprint-cut-half-over-30-years - accessed 12 October 2022.

Centre for European Policy Studies (CEPS) (2014). The EU Furniture Market Situation and a Possible Furniture Products Initiative. Final Report for the European Commission. Available at : https://www.ceps.eu/download/publication/?id=8866&pdf=Final%20report_en.pdf – accessed 20 September 2022.

Cembureau (2021). The story of cement manufacture. Fact sheet. Available at : https://cembureau.eu/media/drylkjo0/manufacturing-process-factsheet_update-jan2021.pdf - accessed 17 August 2022.

Changing Markets (2021). Synthetics Anonymous. Fashion Brand's Addition to Fossil Fuels. Report. Available at: https://changingmarkets.org/wp-content/uploads/2021/07/SyntheticsAnonymous_FinalWeb.pdf - accessed 19 October 2022.

Dietz, B. (2005). Life Cycle Assessment of Office Furniture Products. Report No. CSS05-08. Center for Sustainable Systems, University of Michigan.

Edwards & Hill Office Furniture (2020). Office Furniture Lifespan: How Long Does It Last?. Edwards & Hill Office Furniture. Accessed September 20, 2022. https://www.edwardsandhill.com/blog/office-furniture/office-furniture-lifespan-how-long-does-it-last/ accessed 12 September 2022.

Emele, L., Graichen, J., & Mendelevitch, R. (2022). Decomposition analysis of CO_2 emissions in the European cement sector.

Energy Efficiency in Industrial Processes (EEIP) (2022). Deep decarbonisation of industry: The cement sector. Report. Available at: https://ee-ip.org/en/article/deep-decarbonisation-of-industry-the-cement-sector-1773 - accessed 12 October 2022.

Environment Agency (2017). "Climate change agreements - Guidance.". Available at: https://www.gov.uk/guidance/climate-change-agreements--2#about-climate-change-agreements – accessed 12 September 2022.

Enkvist, P. A., & Klevnäs, P. (2018). The circular economy—A powerful force for climate mitigation. Material Economics: Stockholm, Sweden.

European Environmental Agency (EEA) (2019): Textiles in Europe's circular economy. Briefing 10/2019. Available at:

https://www.eea.europa.eu/publications/textiles-in-europes-circular-economy/textiles-in-europe-s-circular-economy - accessed on 12 September 2022.

European Environment Bureau (EEB) (2017). Circular Economy Opportunities in the Furniture Sector. Report. Available at: https://eeb.org/wp-content/uploads/2019/05/Report-on-the-Circular-Economy-in-the-Furniture-Sector.pdf - accessed 18 August 2022.

European Environmental Bureau (EEB) (2021). Delays in ecodesign implementation threaten 55% climate target and cost citizens billions. Available at : https://eeb.org/wp-content/uploads/2022/04/EEB_ECOS-Delays-in-ecodesign-report.pdf - Accessed on 5 October 2022.

European Commission (2011). Domestic and commercial ovens (electric, gas, microwaves), including when incorporated in cookers. Lot 22. Preparatory Studies for Ecodesign Requirements of EuPs (III). August 2011.

European Commission (2018). A Clean Planet for all: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy. Available at : https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_en.pdf - Accessed on 13 September 2022

European Commission (2022). Commission Staff Working Document (Impact Assessment) accompanying the proposed regulation COM(2022) 142. SWD(2022) 82. Available at: https://environment.ec.europa.eu/system/files/2022-03/SWD_2022_82_1_EN_impact_assessment_part1_v2.pdf - Accessed on 12 September 2022.

European Parliament (2020). The impact of textile production and waste on the environment (infographic). Available at: The impact of textile production and waste on the environment (infographic) | News | European Parliament (europa.eu) - Accessed on 12 October 2022.

Fayomi, G. U., Mini, S. E., Fayomi, O. S. I., & Ayoola, A. A. (2019). Perspectives on environmental CO2 emission and energy factor in Cement Industry. In IOP Conference Series: Earth and Environmental Science (Vol. 331, No. 1, p. 012035). IOP Publishing.

Forrest, A., Hilton, M., Ballinger, A., & Whittaker, D. (2017). Circular economy opportunities in the furniture sector. European Environmental Bureau: Brussels, Belgium.

Furniture Industry Research Association. (2011). A study into the feasibility of Benchmarking carbon footprints of furniture products.

Gallego-Schmid, A., Mendoza, J. M. F., & Azapagic, A. (2018a). Environmental assessment of microwaves and the effect of European energy efficiency and waste management legislation. Science of the Total Environment, 618, 487-499.

Gallego-Schmid, A., Jeswani, H. K., Mendoza, J. M. F., & Azapagic, A. (2018b). Life cycle environmental evaluation of kettles: Recommendations for the development of eco-design regulations in the European Union. Science of the Total Environment, 625, 135-146.

Goworek, H., Oxborrow L., Claxton, S., McLaren, A., Cooper, T., Hill, H. (2020). Managing sustainability in the fashion business: Challenges in product development for clothing longevity in the UK. Journal of Business Research, 117, 629-641.

GPC (2019). Reducing CO2 through clinker replacement. Article. Available at: https://gcpat.vn/en-gb/about/news/blog/reducing-co2-through-clinker-replacement - accessed 25 October 2022.

IEA (2018), Technology Roadmap - Low-Carbon Transition in the Cement Industry, IEA, Paris. Available at: https://www.iea.org/reports/technology-roadmap-low-carbon-transition-in-the-cement-industry - accessed 20 September 2022.

Kazan, H., Akgul, D., & Kerc, A. (2020). Life cycle assessment of cotton woven shirts and alternative manufacturing techniques. Clean Technologies and Environmental Policy, 22(4), 849-864.

Kalliala, E. M., & Nousiainen, P. (1999). Environmental profile of cotton and polyester-cotton fabrics. AUTEX Research Journal, 1(1), 8-20.

Kort, M., van der Vusse, R., van Grootel, M. (2020). Ongebruikt textiel. Onderzoek naar de wijze waarop de textielketen omgaat met ongebruikt en nieuw textiel. Onderzoek in opdracht van Ministerie van Infrastructuur en Waterstraat. RebelGroup Executives bv, Rotterdam. Available at: https://open.overheid.nl/repository/ronl-a34602ee-de11-454a-a40a-897f876426b6/1/pdf/eindrapport-omgang-textiel.pdf - accessed 20 September 2022.

Nagel, S. (2010). Exploring ways to reduce greenhouse gas emissions in the textile supply chain. University of Pretoria, October 2010.

OECD (2021), Government at a Glance 2021, OECD Publishing, Paris, https://doi.org/10.1787/1c258f55-en.

Rana, S., Pichandi, S., Karunmoorthy, S., Bhattacharyya, A., Parveen, S., Fangueiro, R. (2015). Carbon Footprint of Textile and Clothing Products. In Handbook of Sustainable Apparel Production (pp. 156-181). CRC Press.

Sustainable Apparel Coalition (SAC) (2021). Draft Product Environmental Footprint Category Rules (PECFR). APPAREL AND FOOTWEAR. Version 1.2, 7 July 2021. Available at: https://eeb.org/wp-content/uploads/2021/11/Draft-Product-Environmental-Footprint-Category-Rules-PEFCR-apparel-and-footwear.pdf - accessed 19 August 2022.

Sridharan, V. (2020). Future of Cement: Low-Carbon Technologies and Sustainable Alternatives. Morningstar Sustainalytics: https://www.sustainalytics.com/esg-research/resource/investors-esg-blog/future-of-cement-low-carbon-technologies-and-sustainable-alternatives#_ednref1 – accessed 20 September 2022.

Spitzley, D. V., Dietz, B. A., & Keoleian, G. A. (2006). Life cycle assessment of office furniture products. Ann Arbor.

Textile Exchange (2021). Preferred Fiber & Materials. Market Report 2021. Available at : https://textileexchange.org/wp-content/uploads/2021/08/Textile-Exchange_Preferred-Fiber-and-Materials-Market-Report_2021.pdf - accessed 20 September 2022.

United Nations Industrial Development Organisation (UNIDO) (2021). Fostering industry transition through green public procurement: A “How to” guide for the cement & steel sectors. Available at: https://www.unido.org/sites/default/files/files/2021-06/Fostering_Industry_Transition_through_Green_Public_Procurement.pdf - accessed 18 October 2022.

Zequan, Wu (2020). Evaluating the Life-cycle Environmental Impacts of Polyester Sports T-shirts. IOP Conference Series: Earth and Environmental Science. 474 (2020) 022017. IOP Publishing. DOI: 10.1088/1755-1315/474/2/022017.

Appendix

Working assumption not specified in the main text	Description of assumption	Link to source
T-shirts: EU-wide sales, p.a.	3.3bn t-shirts sold each year. CE calculation based on figures for domestic production, imports and exports of t-shirts and tops for 2017. In absence of better information and assuming the EU market is saturated, we assume annual sales remain constant over time.	Business Wire market research LINK
Textiles: Unsold textiles and their destruction	Share of unsold textiles: 9% of turnover (France); 6% (Netherlands). *Of which:* Destroyed/recycled: 11% (France), 5.8% (Netherlands). We assume these figures are also representative for T-shirts and calculate figures based on this range.	France: ADEME, 2021 - LINK Netherlands: Kort et al., 2020 - LINK
Microwaves ovens: EU-wide sales, p.a.	Assumption used in the calculations: 18 million units sold p.a.; based on 7.5 year product life and an EU-wide stock of 135 million microwave ovens. An alternative figure would be to multiply microwave ownership rates in the EU reported by Statista (c. 80%) with the number of households in the EU (c. 197 million according to Eurostat), which gives an estimated stock of c. 158 million. We use the lower and more conservative figure.	EU stock of microwaves: Gallego-Schmid et al. (2018a) estimate a stock of 135 million by 2020. Statista ownership rate - LINK Eurostat number of households - LINK
Microwave ovens: product life	Assumptions used in the calculations: 7.5 years. Figures reported in the literature: between 6.5 and 8 years for modern microwaves.	Gallego-Schmid et al. (2018a) – LINK; Mr Appliances - LINK
Electric kettles : EU-wide sales	The preparatory study for Ecodesign Working Plan 2015-2017 reports Prodcom figures of c. 28m sales p.a. (incl. UK), but acknowledges that this could be too low, given reports that 13m units were sold in the UK in 2012 alone. The Stock of kettles in the EU28 reported in Gallego-Schmid et al. (2018b) is 117m-200m; they assume a 142.5; removing the UK (26.7m kettles (ibid.)), gives a figure of 116m. Combining this with an average lifespan of 4.4 years (same study) and assuming the market size	Ecodesign WP2015-2017 prep study: LINK Gallego-Schmid et al. (2018b) - LINK

	remains constant, this gives a figure of 26.3m sales p.a. which we think is reasonable for the EU27.	
Electric kettles: product life	4.4 years, same assumption as used in Gallego-Schmid (2018b); apparently higher quality kettles are manufacturer tested to last seven years, but various online reports also quote around four to five years, therefore we use 4.4 years in our estimates.	Gallego-Schmid et al. (2018b) - LINK; Relevant news articles: One, Two, Three
Cement: EU production	Analysis of Eurostat Prodcom data: EU production of cement and clinker was 196 million tonnes in 2019; considering imports/exports, EU consumption was 190 million tonnes in 2019. We use the figures for EU production in this analysis as the target for Ecodesign interventions. This is also broadly in line with figures reported by Cembureau, just over 180 million tonnes produced in 2019.	Prodcom database (DS-066341) accessible here: LINK Cambureau infographic showing EU27 cement and clinker production: LINK
Office chairs: EU-wide sales (overall and public sector)	EU Prodcom data suggests a value of €2.3bn of EU office chair consumption in 2019 ("swivel seats with variable height adjustments, excluding medial"); assuming an average value of between €150 and €250 per chair, this gives figures between 15.4m and 9.2m annual unit sales. A broad sense check is to estimate the share of the EU workforce based in offices (we assume 50% of 190m workforce), assuming one chair p/p, and dividing this by the average product life, assumed to be eight years (in line with various online sources) – this gives a figure of 11.9m sales p.a. which is within the range cited above.	Eurostat Prodcom Dataset (DS-066341); LINK Online source for product life – between 5 and 10 years, longer for expensive models One, Two, Three
Office desks: EU-wide sales (overall and public sector)	Similar to office chairs, we assume 50% of the EU's 190m workforce require a desk, with an average product life of 15 years – this yields a figure of 6.3m unit sales of EU-wide p.a., which we feel is reasonable.	Online sources for product life: One, Two
Public sector furniture consumption	In absence of better information, we use the public sector share of GDP in the EU (14.9%, OECD) as a proxy for the share of public procurement in total EU office furniture consumption, which is probably conservative. This implies roughly 1.8m office chairs and 1m desks are bought by public sector organisations each year – we use this to illustrate environmental benefits if the public sector bought 'improved' products.	OECD figures on public sector share of GDP: LINK