DELIVERING RESOURCE-EFFICIENT PRODUCTS

How Ecodesign can drive a circular economy in Europe

The EEB provides an environmental voice for European
citizens, standing for environmental justice, sustainable
development and participatory democracy. Our aim is
to promote a healthy environment and rich biodiversity
throughout the EU and beyond.

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Abbreviations

a	year		JRC	Joint Research Centre of the European Commission
ADP	abiotic depletion potential		LCD	liquid crystal display
ADP-el	abiotic depletion potential elements		MEErP	Methodology of Ecodesign of Energy-related Products
CFC	chlorofluorocarbon		MJ	megajoule
CFC11-eq	chlorofluorocarbon-11 equivalents		Mt	mega-tonne (1 million tonnes)
CO2	carbon dioxide		PCB	printed circuit board
CO2-eq	carbon dioxide equivalents		REACH	Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals
DMC	domestic material consumption		RMC	raw material consumption
EEA	European Environmental Agency		Sb	antimony
EEB	European Environmental Bureau		Sb-eq	antimony equivalents
EREP	European Resource Efficiency Platform		SVHC	substances of very high concern
EU	European Union		t	tonne
GHG	greenhouse gases		TE	terrestrial ecotoxicity
GJ	gigajoule		TJ	terajoule
GWP	global warming potential		UBA	Umweltbundesamt (German Federal Environment Agency)
ICT	information and communication technology		UNEP	United Nations Environmental Programme
IC	integrated circuit		WEEE	waste electrical and electronic equipment
IED	Industrial Emissions Directive		WRAP	Waste & Resources Action Programme
IPR	International Resource Panel			

Executive Summary

The intensive use of natural resources worldwide is leading to rising and volatile resource prices. It has also caused severe environmental damage.The International Resource Panel (IPR) of the United Nations Environmental Programme (UNEP) has warned that, by 2050, our current production and consumption patterns, along with increases to the world's population and prosperity, will see humanity's annual consumption of minerals, fossil fuels and biomass reach 140 billion tonnes.[1] This is more than twice the level of today's consumption at 60 billion tonnes.

Europe largely depends on imports of fossil fuels and strategic metals to power its economy and drive its industrial production. According to Eurostat data, 40% of all the raw materials used in the EU were sourced elsewhere.[2] For some raw material categories like metal ores, the import dependency is over 90%.

To face these challenges, the European Commission developed its 'Thematic Strategy on the Sustainable Use of Natural Resources' in 2006[3] and created the 'Roadmap to a Resource Efficient Europe' in 2011.[4] However, to this day, the EU has failed to set a resource conservation target, to agree on a set of indicators

that measure resource use in Europe, or to decide on concrete measures that seriously address the issue. This is despite the tremendous potential that EU-wide product policy and eco-design approaches could have on cutting resource use and promoting a circular economy in the EU. Furthermore, to reduce the damaging impact of excessive resource use on the environment, economic development must be decoupled from the amount of resources we consume which, in turn, must be decoupled from the impact resource use has on the environment.

Figure 1: The two- level 'decoupling' addressed by the European Commission's Thematic Strategy on the Sustainable Use of Natural Resources (2006)
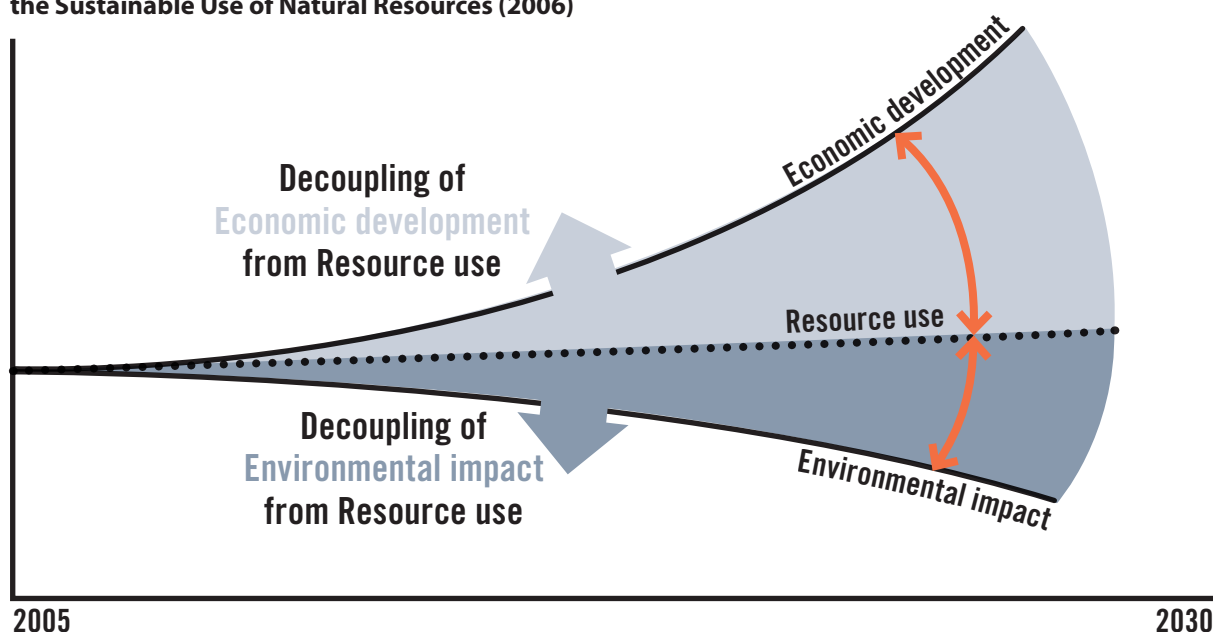
[1] http://www.unep.org/resourcepanel/publications/decoupling/tabid/56048/default.aspx.

[2] Based on: Eurostat (2014): Material flow accounts in raw material equivalents - modelling estimates (env_ac_rme). Available online at http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database, last accessed 11/6/2014.

[3] European Commission (2005): Thematic Strategy on the Sustainable Use of Natural Resources. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of Regions. 670. Available online at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52005DC0670&qid=1410868527389, last accessed 9/16/2014.

[4] European Commission (2011): Roadmap to a Resource Efficient Europe. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels. Available online at http://ec.europa.eu/environment/resource_efficiency/pdf/com2011_571.pdf, last accessed 6/13/2014.

Why EU product policy matters

The amount of resources used in a product during its life time is, to a large extent, determined during the design phase. These design decisions influence the type and amount of materials used in production, how long a product will last, if it will be repairable and if the materials contained in the product can be recycled. Resource-use aspects can in fact be covered across a range of different policy instruments including Ecolabel, Green Public Procurement, and the Ecodesign and Energy-Labelling Directives.

Design decisions concerning energy-using products have mostly been regulated at EU level under the Ecodesign Directive since 2005. However, efforts to date have focused on reducing energy consumption during the use phase of these products, with resource use aspects covered in only isolated cases. This report shows that the Ecodesign Directive is nevertheless well suited to set design requirements that increase a product's resource efficiency.

Indicators and priorities

Identifying the resource impact of extracting and processing virgin materials that are 'embedded' in a product is complex and requires the use of different indicators, such as cumulative Raw Material Consumption (RMC), freshwater and land use or toxicity, to provide the bigger picture. Most studies today use Global Warming Potential (GWP) as a proxy indicator for resource use, which is expressed as CO_2 equivalent of Greenhouse Gas (GHG) emissions. Although imperfect, because it doesn't cover all resource use related impacts, GWP is a well documented and accepted approach ready to use.

Calculations made in this report show that selected electrical and electronic devices placed on the EU market over one year cause the equivalent of 1,500 million tonnes of CO_2 emissions over their lifecycle. This corresponds to the entire energy production of the UK, Germany and Poland put together. For the same product categories, the 'embedded' CO_2 equivalent emissions, which relate to the materials contained in the products, amount to 100 million tonnes over one year.[5] This covers electronics, motors and pumps, lighting, heating and cooling appliances as well as photovoltaic panels and wind turbines.

SELECT PRODUCT CATEGORIES
PLACED ON EU MARKET OVER ONE YEAR

electronics   lighting   heating and cooling   motors and pumps   solar panels and wind turbines

LIFECYCLE

1,500 MT CO2 EMISSIONS over their lifecycle **=** **TOTAL ENERGY PRODUCTION OF UK + GERMANY + POLAND** over one year

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6 See chapter 2.3 Assessing the impact of individual product groups on resource use – from the bottom up

When looking at desktop PCs and microwaves, the share of CO_2 equivalent emissions 'embedded' at the design stage of the product, out of the total emissions over the product's lifecycle, is at least 25%. For notebooks, the corresponding figure is 50%. However, in setting priorities for individual product groups, both the share of greenhouse gas emissions embedded in a product and the number of products sold on the market should be taken into account. This is particularly important in relation to, for instance, TVs, vacuum cleaners, and washing machines. These product groups have a significant amount of greenhouse gas emissions 'embedded' because they are sold in large numbers.

Improvements to products in energy efficiency during the use phase, combined with an increased use of complex electronic components in products, means that the relative weight of GHG emissions 'embedded' in products will grow when looking at a product's emissions over its lifecycle. As a result, the attention of policy-makers should gradually shift from the use phase to the design and production phase.

Unlocking the benefits of greater resource efficiency

From a societal perspective, few argue against the need to develop more resource efficient products. Such products will allow a better handling of priority materials, which Europe imports at high levels and the extraction of which causes environmental damage. They are also a precondition for new business models to develop around repair and maintenance services, leasing and rental options and so-called 'reverse engineering solutions.' A study for the European Commission has estimated that increasing resource productivity by 2% per year could create two million extra jobs in the EU by 2030.[6] In 2013,

the Ellen MacArthur Foundation stated that part of the EU manufacturing sector could benefit from net material cost savings worth up to €410-490 billion per year by 2025, simply by stimulating economic activity in the areas of product development, remanufacturing and refurbishment.[7]

Product policy can address resource efficiency in a similar way to energy efficiency. Minimum requirements which lengthen a product's lifespan and make repair more affordable would be strongly supported by consumers, a recent Eurobarometer survey among EU citizens confirms.[8] There are various ways of unlocking this potential. These include financial incentives for the developers of new products, through targeted R&D funds or easily accessible investment capital, market pull instruments, such as public procurement rules or meaningful Eco-Labelling criteria. But only Ecodesign implementing measures can create a level playing field for all market players by setting binding minimum requirements for resource efficiency that justify long-term financial investments in this direction. Providing long-term visibility and legal certainty is particularly important for producers and operators within the refurbishment, remanufacturing and recycling industries to enhance the cost effectiveness and development potential of these activities.

To drive new business models and industrial practices, the EU needs to set detailed and quantified resource conservation targets. This will boost the importance of resource efficiency within the Ecodesign agenda. But, until such targets have been agreed and an appropriate set of indicators is chosen to measure resource conservation, this report outlines a pragmatic approach to start creating resource savings through product policy.
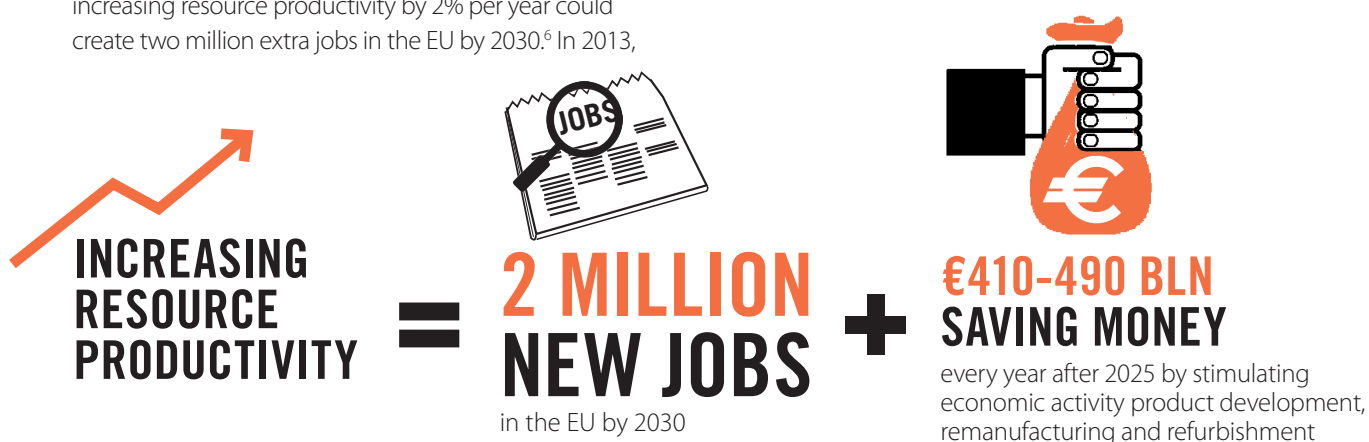
INCREASING RESOURCE PRODUCTIVITY **=** **2 MILLION NEW JOBS** in the EU by 2030 **+** **€410-490 BLN SAVING MONEY** every year after 2025 by stimulating economic activity product development, remanufacturing and refurbishment

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[6] European Commission (2014): 'Study on modelling of the economic and environmental impacts of raw material consumption': http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/RMC.pdf.
[7] Equals US$ 520-630 billion in the advanced scenario for a circular economy modelled by Ellen Mac Arthur Foundation (2013): 'Towards the circular economy – economic and business rationale for an accelerated transition'.
[8] European Commission (2013): Flash Eurobarometer 367 – Attitudes of Europeans Towards Building the Single Market for Green Products. http://ec.europa.eu/public_opinion/flash/fl_367_sum_en.pdf.

A pragmatic approach to resource conservation in Ecodesign

The report highlights three options that can easily be combined together to reduce resource use in products:
- Identify design requirements that support better repairability and durability of products;
- Ensure that selected materials in products are managed carefully from production to end-of-life, including options to use high shares of recycled content and support their high-quality recyclability;
- Remove problematic or hazardous substances undermining the potential for re-using material from products.

HOW TO CUT RESOURCE USE WITH ECODESIGN

BETTER REPAIRABILITY AND DURABILITY of products

+

HIGHER RECYCLABILITY of materials

+

REMOVAL OF HAZARDOUS SUBSTANCES
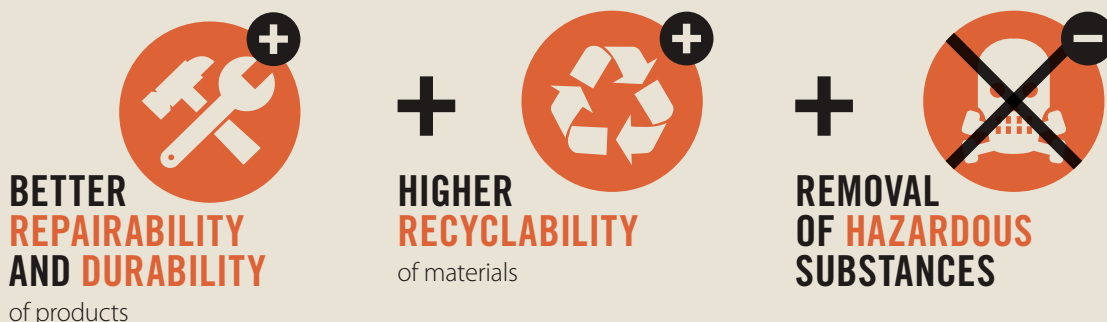
Prolonging the lifetime of a product, compared to replacing it early, can deliver significant resource savings. Carrying out a range of simple, already feasible design options to extend the lifetime of laptops, printers and washing machines in the EU could lead to savings in GHG emissions of over 1 million tonnes per year, which is the equivalent of taking 477,000 cars off the road for a year.[9]

Recycled content uses fewer natural resources and energy during its manufacturing than primary material. The recycling of one kilogramme of plastic, for example, saves up to 70 MJ (Mega Joules)[10], which corresponds to the energy content of more than 2 liters of petrol and is sufficient to drive an average European passenger car up to 50 km. Ensuring the recyclability of metals contained in products, especially precious ones, is important. The extraction of gold from electronic waste saves around 80% of GHG emissions compared to its extraction from ore.[11]

Linking Ecodesign requirements with waste treatment processes makes sense. For example, having requirements to remove Printed Circuit Boards (PCBs) and Integrated Circuits (ICs) from discarded devices before they end up in unspecific shredding and melting is far more efficient with regard to the recovery rate for precious metals. Enabling a separate treatment of PCBs and ICs from a range of different products could result in about 1,300 tonnes of additional recycled copper every year.[12]

In addition, establishing mandatory information requirements on resource aspects and design under the Ecodesign Directive could have a real impact on resource conservation efforts. The information could accompany the product when it is purchased or be easily accessible in a standardised format on the internet to help downstream users like repair shops, re-use facilities or end-of-life treatment centers.

PROLONGING THE LIFETIME OF A PRODUCT through feasible design options

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+1MT PER YEAR REDUCTION IN GHG EMISSIONS GHG

477,000 CARS OFF THE ROAD FOR ONE YEAR

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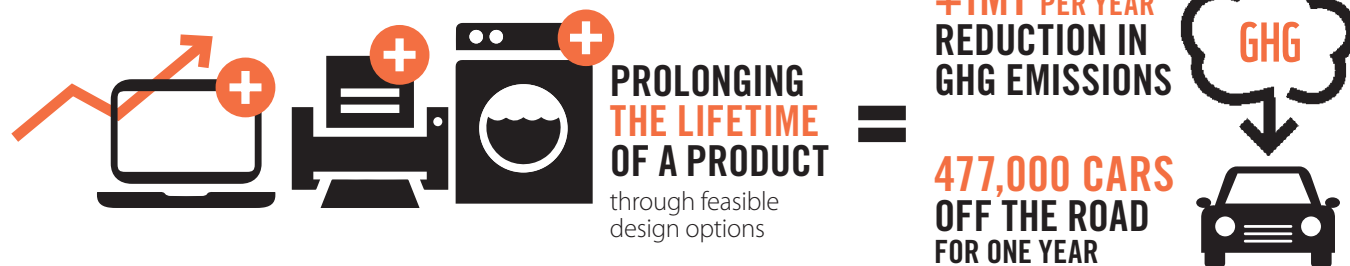
[9] See chapter 3.3 The potential of prolonging the use phase.
[10] This depends on the type of plastic and process used for recycling. The values of 30-70 MJ (54-87%) saving per kg of plastic are taken from the MEErP methodology (EU figures) (see chapter 5.1).
[11] Hagelüken, Christian; Corti, Christopher W. (2010): Recycling of gold from electronics: Cost-effective use through 'Design for Recycling'. Gold Bull 43 (3), p. 209-220.
[12] This calculation is based on data from the Ecodesign preparatory studies for the following products: washing machines, microwaves, televisions (LCD-TV, PDP-TV & CRT-TV), desktop computers, laptops, flat panel monitors, coffee machines, simple and complex set-top boxes, printers, copiers.

1. INTRODUCTION

The urgent need to decouple escalating resource use and environmental degradation from economic activity and human wellbeing is now widely acknowledged by policy-makers, industry leaders and civil society. The International Resource Panel (IPR)[1] of the United Nations Environmental Programme (UNEP) has pointed out that the worldwide use of natural resources is accelerating – annual material extraction grew by a factor of eight through the twentieth century.

The IPR warned that our current production and consumption patterns, along with increases to the world's population and prosperity, will mean that by 2050 humanity consumes 140 billion tonnes of minerals, ores, fossil fuels and biomass per year. This is more than twice the amount of today's consumption levels of 60 billion tonnes. This unsustainable use of natural resources already has a severe impact on price volatility and causes severe environmental damage.

Europe largely depends on imports of fossil fuels like oil, natural gas and coal to power its economy but it also imports many other resources for its industrial production. European consumption and production depends on imports for about 40% of its raw material equivalents, which include the raw materials in imported products[2]. For some raw material categories like metal ores the import dependency is above 90%.

As a result, resource efficiency has become a high priority in current strategic debates both at European Union (EU) level and at member state level. This agenda covers far more than just the environmental implications of resource use. It is also about Europe's long term economic development. But for now, this agenda's implementation remains rather vague. The European Environmental Agency (EEA) released an analysis of the policy framework needed for a resource-efficient green economy in July 2014.[3] The ongoing work of the Ellen MacArthur Foundation[4] focuses on how to unlock the environmental, social and economic benefits of a circular economy which requires not only end-of-life policies for products but,

above all, a clear link to the design phase of products where resource input and environmental impacts are highest. In a 2013 report[5] the Ellen Macarthur Foundation stated that part of the EU manufacturing sector could realise net materials cost savings worth up to € 490 billion per year by 2025 simply by stimulating economic activity in the areas of product development, remanufacturing and refurbishment.

The European Resource Efficiency Platform (EREP)[6] was established by the European Commission as a high level advisory panel with representatives from EU institutions, national governments, local and regional authorities, business and civil society. It stressed the need for a coherent product policy framework in its final policy recommendations: *'Resource efficiency requires a dynamic fiscal and regulatory framework that gives appropriate signals to producers and consumers to supply and demand products with lower environmental impact over the whole life cycle ... This would cover warranties, durability, upgradability or recyclability requirements, eco-design requirements, as well as indicators, benchmarks and financial and non-financial incentives.'*

In this context the EU has set itself, through the 7th Environmental Action Programme to 2020[7], the target of becoming a resource-efficient, green and competitive low-carbon economy. The annex to this decision (paragraph 36) is clear: *'... the Union policy framework should ensure that priority products placed on the Union market are 'eco-designed' with a view to optimising resource and material efficiency. This*

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[1] http://www.unep.org/resourcepanel/publications/decoupling/tabid/56048/default.aspx.

[2] Based on: Eurostat (2014): Material flow accounts in raw material equivalents - modelling estimates (env_ac_rme). Available online at http://epp. eurostat.ec.europa.eu/portal/page/portal/statistics/search_database, last accessed 11/6/2014.

[3] See 'Resource-efficient green economy and EU policies': http://www.eea.europa.eu/publications/resourceefficient-green-economy-and-eu.

[4] http://www.ellenmacarthurfoundation.org/

[5] Ellen MacArthur Foundation: 'Towards the circular economy – economic and business rationale for an accelerated transition', 2013

[6] http://ec.europa.eu/environment/resource_efficiency/re_platform/index_en.htm

should include addressing, inter alia, product durability, reparability, re-usability, recyclability, recycled content and product lifespan. Products should be sustainably sourced and designed for re-use and recycling.'

This aspiration was reflected in the European Commission's Circular Economy Package, released in July 2014, which emphasised that *'an important starting-point is the design of production processes, products and services. Products can be redesigned to be used longer, repaired, upgraded, remanufactured or eventually recycled, instead of being thrown away.'* [8]

With *'Delivering Resource Efficient Products,'* the European Environmental Bureau (EEB) wishes to highlight both the necessity and the feasibility of reducing resource consumption through EU product policy. This report intends to deliver practical examples of approaches to tackle resource use using current policy instruments, in particular the Ecodesign Directive 2009/125/EC which establishes a framework for the setting of ecodesign requirements for energy-related products. [9] There are substantial benefits on offer if both energy and resource consumption are tackled in the Ecodesign Directive and links between Ecodesign and the Commission's Circular Economy Package are strengthened. [10]

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[7] Decision No. 1386/2013/EU; http://ec.europa.eu/environment/newprg/

[8] Communication from the Commissions to the European Parliament, the European Economic and Social Committee and the Committee of the Regions: Towards a circular economy: A zero waste program for Europe (July 2014) or http://ec.europa.eu/environment/circular-economy/.

[9] http://ec.europa.eu/enterprise/policies/sustainable-business/documents/eco-design/index_en.htm

[10] http://ec.europa.eu/environment/circular-economy/

2. PRODUCTS – A KEY PART OF RESOURCE EFFICIENCY STRATEGIES

2.1 What do we mean by 'resources'?

It is striking that many of the documents drawn up to discuss resource policy are vague when it comes to defining the term 'resources'. This is problematic because of the vast array of things that can fit under this umbrella term.

Scientists tend to use a broad definition when they use the term 'natural resources'. For instance, a report by European environmental protection agencies says the term encompasses:

'All components of nature that offer direct benefits for humankind; e.g. raw materials, land, genetic resources. Natural resources also include services which nature indirectly provides for humankind, e.g. the absorption of emissions (sink function) and the maintaining of ecological biogeochemical systems.'[11]

This broad understanding includes biodiversity as well as the so-called sink function, which is the limited capacity of the 'ecosphere' to absorb pollutant emissions. The following image illustrates this idea:

Figure 2: A broad understanding of the term 'natural resources' (ecosphere)

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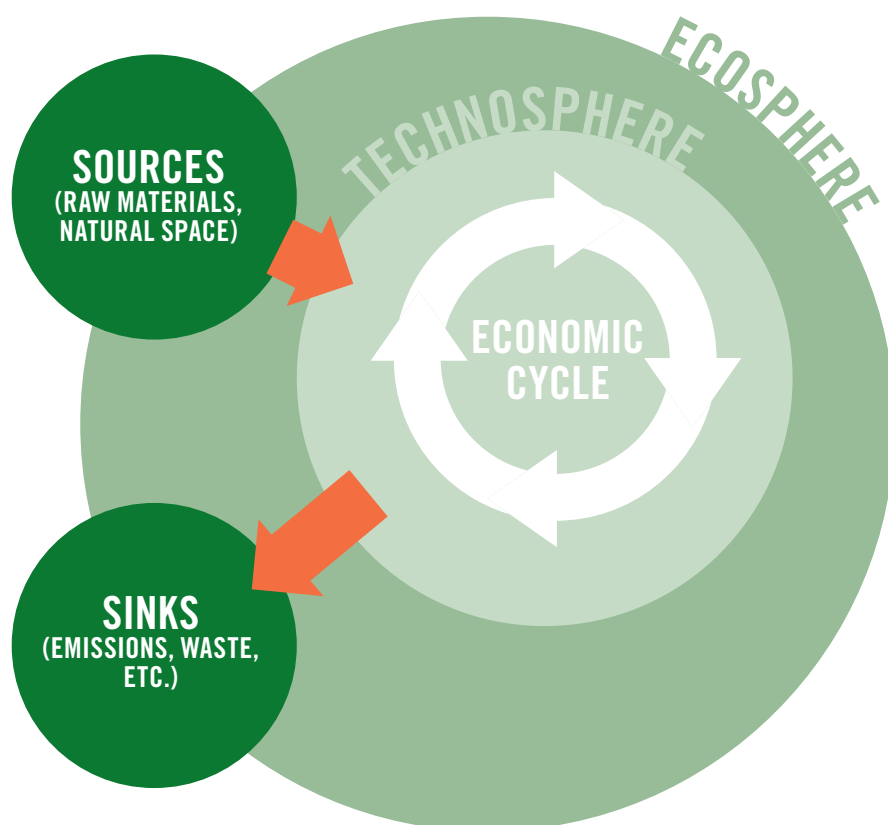
[11] Federal Environment Agency Austria et. al. (2006): Delivering the sustainable use of natural resources: A contribution from the following members of the Network of Heads of European Environment Protection Agencies on the Thematic Strategy on the Sustainable Use of Natural Resources. http://www.umweltbundesamt.de/sites/default/files/medien/pdfs/EPA_resourcespaper_2006.pdf, last accessed 16/9/2014, p. 11.

A similar definition is used, among others, by UNEP:[12]

"Resources: The naturally occurring assets that provide use benefits through the provision of raw materials and energy used in economic activity (or that may provide such benefits one day) and that are subject primarily to quantitative depletion through human use. They are subdivided into four categories: mineral and energy resources, soil resources, water resources and biological resources."

In contrast to this broad understanding of 'natural resources' is the approach of the European Commission's Ad hoc Working Group on Defining Critical Raw Materials, which is focused on the supply of industry with strategically relevant metals and minerals.[13] The image below indicates the different categories of 'natural resources' and what the Commission's working group understands by 'critical raw materials'.[14]

Figure 3: What is meant by 'resources'

RESOURCE CATEGORIES

Water — Air — Raw Materials — Soil/land area — Biodiversity

Abiotic raw materials — Biotic raw materials

Non-energy raw materials — Energy raw materials

Ores — Industry minerals — Con-struction minderals — Other uses — Food — Energy carriers

CRITICAL RAW MATERIALS

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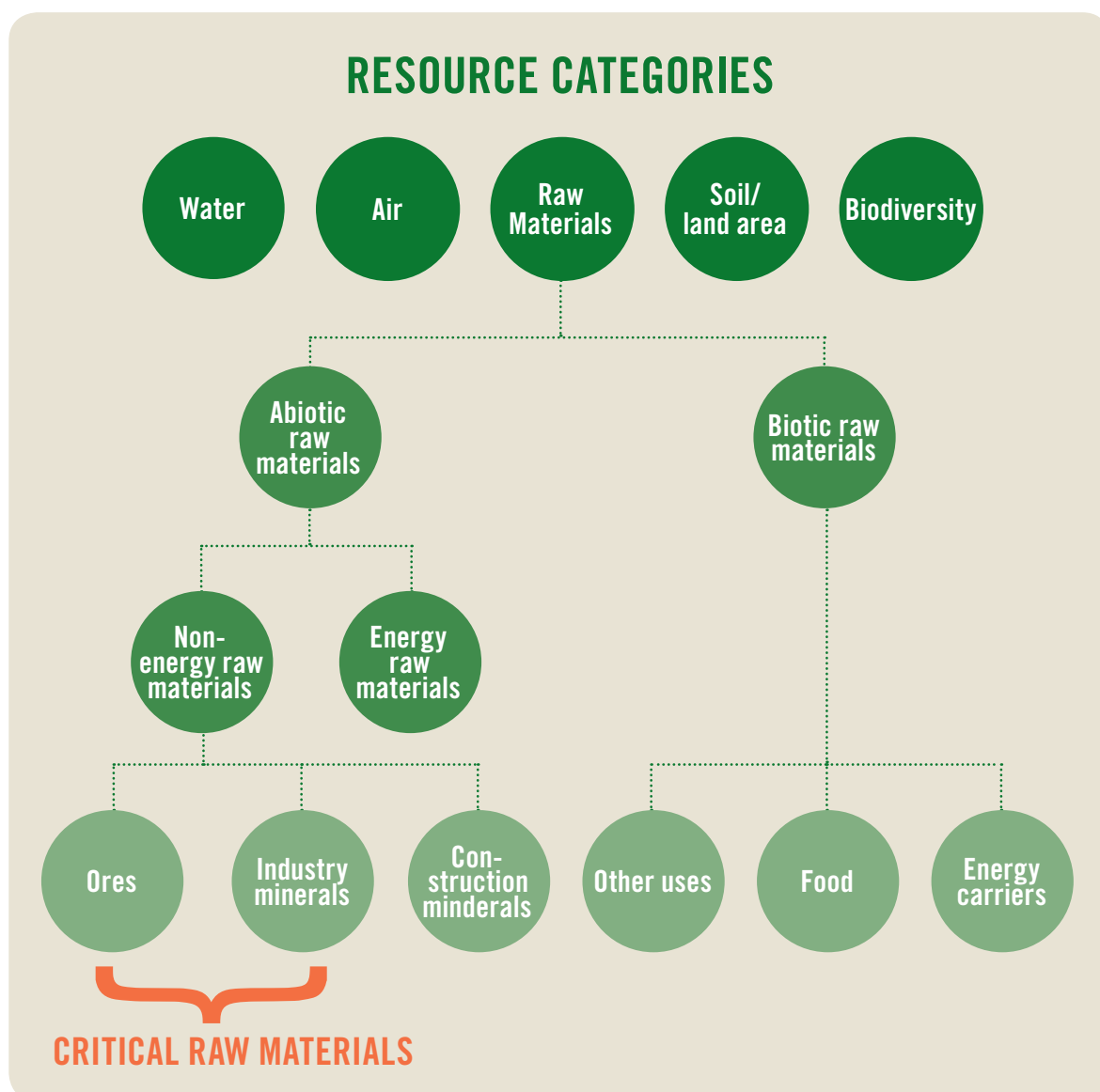
[12] United Nations Environment Programme (2010): ABC of SCP. Clarifying Concepts on Sustainable Consumption and Production. http://www.uneptie.org/scp/marrakech/pdf/ABC%20of%20SCP%20-%20Clarifying%20Concepts%20on%20SCP.pdf, last accessed 16/9/2014.

[13] European Commission (2014): Report on Critical Raw Materials for the EU. Report of the Ad hoc Working Group on Defining Critical Raw Materials. http://ec.europa.eu/enterprise/policies/raw-materials/files/docs/crm-report-on-critical-raw-materials_en.pdf. See also http://ec.europa.eu/enterprise/policies/raw-materials/critical/index_en.htm.

[14] Most discussions on resource efficiency and even more so the debate on critical raw materials only deals only with the input side of production ('sources'), therefore the 'sinks' are not considered in detail in this figure.

The critical raw material approach reduces the debate on resource preservation to the exploitation of a limited number of raw materials used in technical goods. From an economic point of view, potential resource scarcity is of the utmost importance. However, from an environmental perspective, the resources necessary to exploit, mine and process these raw materials, such as biodiversity, drinking water or the capacity of the sink to absorb emissions being set free during these processes, are key.

Moreover, technical products require the use of technical materials instead of raw materials. Today these are rarely mono-materials and, for the most part, are rather complex combinations of different substances, which obtain their specific technical features through the use of additives and alloys or other combinations of substances.

All the substances contained in these technical materials are obtained in more or less extensive processes of synthesis and transformation from raw materials, which require additional energy and resource input.

The resource or environment-related 'value' [15] of a technical material is therefore made up of the aggregated demands made on resources during the steps of raw material extraction, substance composition, and creation of technical materials. Figure 4 shows in a simplified way the aggregation of the resource use until a technical material is finalised:

Figure 4: Aggregated resource use for technical materials

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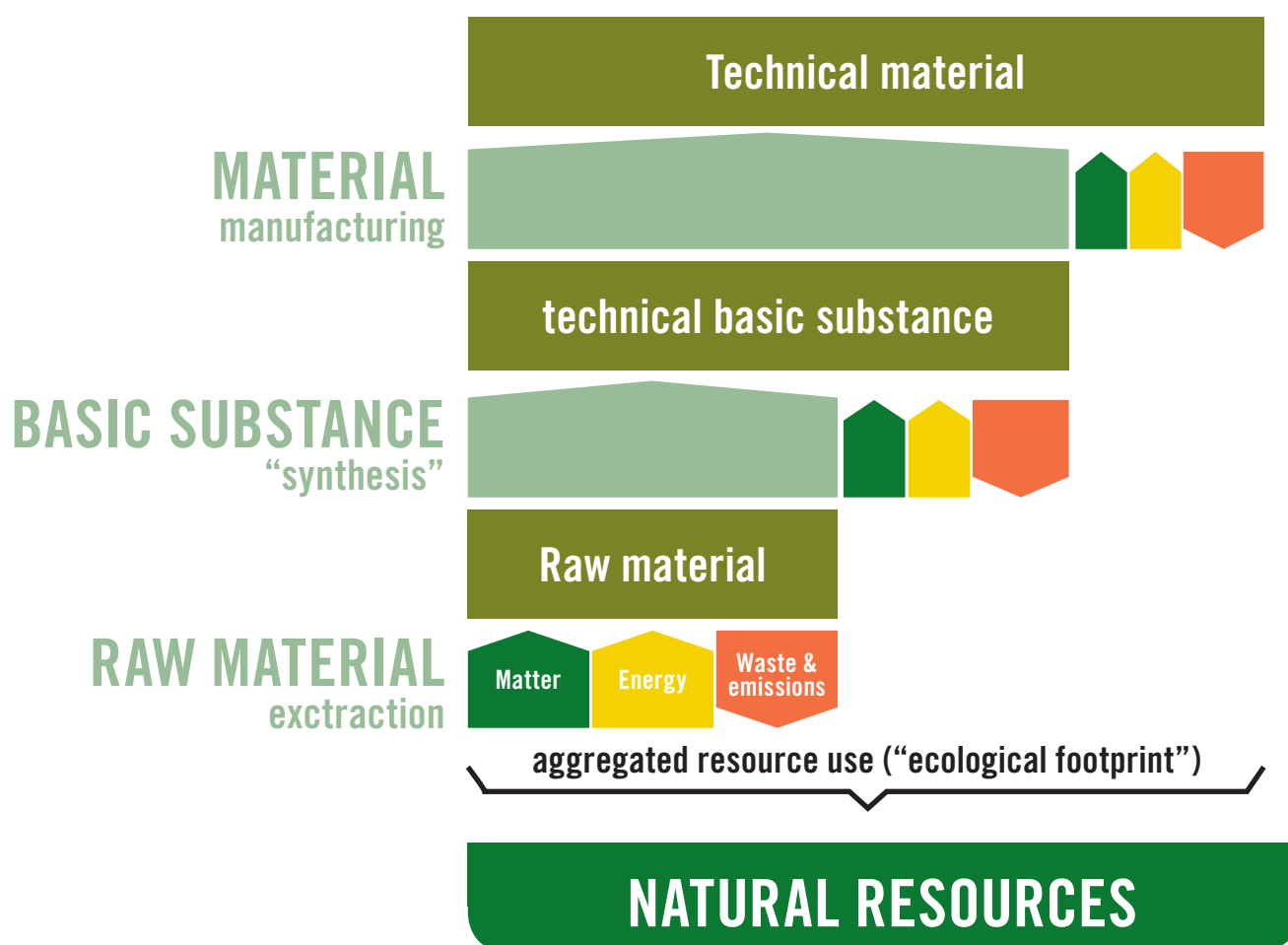
[15] Sometimes also called the ecological footprint.

Understanding this aggregation is important because the majority of the treatment and recycling processes established today is able to recover only a limited amount of the substances contained in (complex) technical materials. What is left becomes waste[16], or contaminants in secondary material[17], and a share of the resources embedded[18] in the materials is therefore lost.[19]

From an environmental protection perspective, we have to differentiate between resource conservation, which implies a reduction in the absolute use of natural resources, and resource efficiency, which is the reduction of resources used per product or functional unit. The latter suggests an economic interest in improving the productivity of resource inputs, which always involves the risk that efficiency gains can lead to higher overall outputs even though the resource input per unit is stagnant or decreasing. Such 'rebound effects' have been observed in various cases.[20]

2.2   The role of product policy in EU targets on resource use

The Thematic Strategy on the Sustainable Use of Natural Resources of the EU of 2006[21] aimed at reducing the negative environmental impacts of excessive resource use within a growing economy. This is supposed to happen at two levels: on the one hand, there needs to be a decoupling of resource use from economic growth (dematerialisation); and on the other, there has to be a reduction in the adverse environmental impacts of resource use, for instance by substituting certain materials (trans-materialisation).

Figure 5: The two- level 'decoupling' addressed by the European Commission's Thematic Strategy
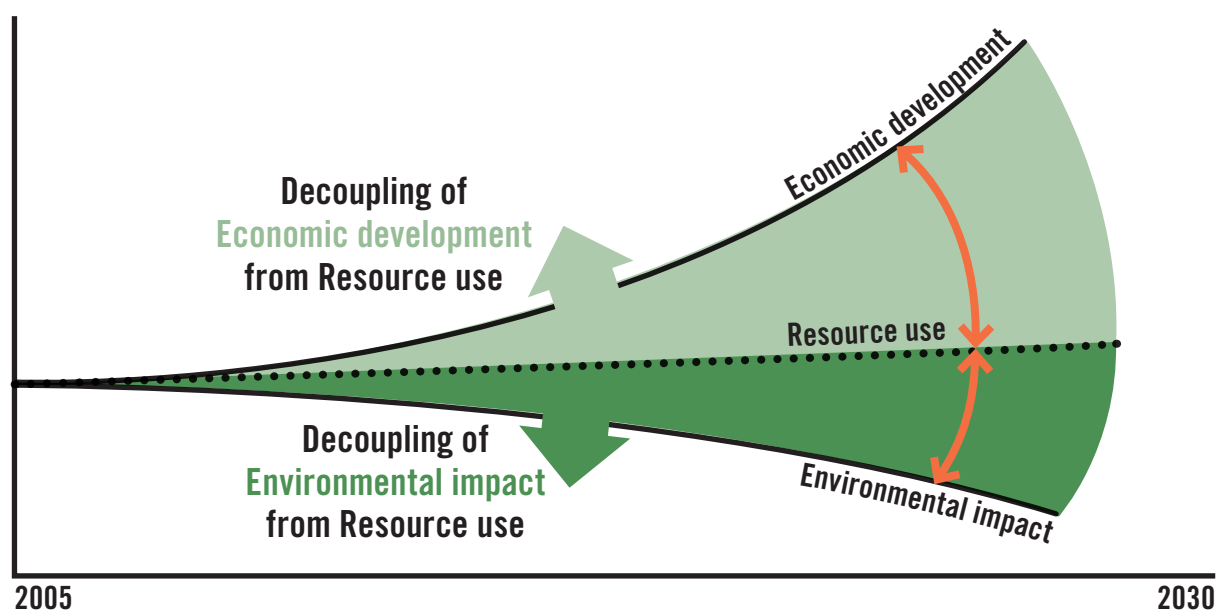
[16] This is the case for example for many of the alloy elements of high-strength steel, which are costly to obtain and are then converted into slag in the process of remelting to obtain secondary steel.

[17] A typical example are UV stabilisers or flame retardant additives in plastics, which end up randomly in secondary plastics as partly toxic contaminants and limit the usability of the recyclates.

[18] Different terms are commonly used for these resources used to produce the materials like the 'indirect resource use of material' or 'unused/hidden material flows'. Traditionally these amounts of materials 'lost' during the preproduction have not been considered in trade statistics and other accounting systems but things have started to change as will be explained in the next chapter.

[19] In addition, the recycling processes themselves require a significant input of resources, for instance in the form of process energy or additional substances.

[20] For instance the energy use per cm2 of TV screens was reduced substantially over the past years. But an increasing number of devices per household, and a continuing trend for ever larger screen sizes, has cancelled out efficiency gains.

[21] European Commission (2005): Thematic Strategy on the Sustainable Use of Natural Resources. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of Regions. 670. Available online at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52005DC0670&qid=1410868527389, last accessed 9/16/2014.

Despite its good intentions, the strategy failed to put in place any concrete quantified or action-guiding targets or measures for resource management. What the strategy did manage was to get EU Member States to establish national programmes on resource conservation.

Nevertheless, the Europe 2020 strategy, which the European Council adopted in 2010, has 'a resource-efficient Europe' as one of its flagship initiatives.[22] The initiative aims to decouple economic growth from resource use, supporting the transition towards a low-emission economy, fostering energy efficiency and the use of renewable energies as well as modernising the traffic system. However, it does not quantify any targets either.

On 20 September 2011, the Commission presented its 'Roadmap to a Resource Efficient Europe' where it fleshes out the flagship initiative[23] by providing the following vision:

'By 2050 the EU's economy has grown in a way that respects resource constraints and planetary boundaries, thus contributing to global economic transformation. Our economy is competitive, inclusive and provides a high standard of living with much lower environmental impacts. All resources are sustainably managed, from raw materials to energy, water, air, land and soil. Climate change milestones have been reached, while biodiversity and the ecosystem services it underpins have been protected, valued and substantially restored.'

The roadmap argues that a new wave of innovations is required, and sets 18 concrete milestones from economic reforms to the maintaining of natural capital and ecosystem services. These milestones are supposed to define staged targets, which will take the EU on a path to better resource conservation and sustainable growth. As a milestone for the field of 'sustainable consumption and production', it states[24]: *'By 2020, citizens and public authorities have the right incentives to choose the most resource efficient products and services, through appropriate price signals and clear environmental information. … Minimum environmental performance standards are set to remove the least resource efficient and most polluting products from the market. Consumer demand is high for more sustainable products and services.'* The Ecodesign Directive is mentioned elsewhere as one of the instruments that can achieve this milestone.

The roadmap also contains a number of proposals for indicators and qualitative targets in its annex.[25] However, both a quantification of (reduction) targets for the implementation of the roadmap and an allocation of contributions to the particular action fields or milestones are missing. The Circular Economy Package, which was proposed in July 2014, included a possible, yet non-binding, 30% target for increasing resource productivity by 2030.[26] However, in the meantime, the Commission has withdrawn the package and stated it will return with a new proposal by the end of 2015.

2.3   Measuring the absolute resource impact of all products (top-down approach)

In order to to assess the relevance of product policy measures for resource conservation, crucial information is needed about:
- The total resource use by all products
- The total resource use of the European Union or of other fields of action as a measure for comparison

Currently, there are significant obstacles to obtaining this information. The measure called Domestic Material Consumption (DMC) which has so far been used in statistical analyses in the EU to trace the development of resource use[27] is not appropriate, particularly for products which are imported in high shares,

[22] European Commission (2011): A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of Regions. 21. Brussels. Available online at http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf, last accessed 9/16/2014.

[23] European Commission (2011): Roadmap to a Resource Efficient Europe. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels. Available online at http://ec.europa.eu/environment/resource_efficiency/pdf/com2011_571.pdf, last accessed 6/13/2014.

[24] Id., p. 6.
Annex 6: European Commission (2011): Analysis associated with the Roadmap to a Resource Efficient Europe - Part 2. Commission Staff Working Paper. Available online at http://ec.europa.eu/environment/resource_efficiency/pdf/working_paper_part2.pdf, last accessed 6/13/2014.

[25] European Commission (2014): Towards a circular economy. Available online at http://eur-lex.europa.eu/resource.html?uri=cellar:50edd1fd-01ec-11e4-831f-01aa75ed71a1.0001.01/DOC_1&format=PDF, last accessed 9/16/2014, see also http://ec.europa.eu/environment/circular-economy/.

[26] European Commission (2014): Towards a circular economy. Available online at http://eur-lex.europa.eu/resource.html?uri=cellar:50edd1fd-01ec-11e4-831f-01aa75ed71a1.0001.01/DOC_1&format=PDF, last accessed 9/16/2014, see also http://ec.europa.eu/environment/circular-economy/.

such as consumer electronics and information and communication technology (ICT) products. Whereas for intra-European production chains the total amount of material used is in principle aggregated, only the weight of imported products is registered. This leads to significant errors in assessments, especially in the case of electronic products with high-purity technical metals which have resource-extensive manufacturing chains.

Moreover, from an environmental perspective, the final use of raw materials itself does not represent a major problem, but the use of other natural resources linked to the extraction and processing of raw materials does. The following table shows selected indicators for the natural resource impacts of different metals.

Table 1: Impact on natural resources - indicators for different metals used in technical products

	Importance for technical goods	Impact on natural resources[28]			
	Share of total use of material worldwide that is used in electrical products [29]	Cumulative greenhouse effect [t CO2-eq/t]	Land use [m2/t]	Cumulative raw material demand [t/t]	Gross energy demand [GJ/t]
Aluminium	1%	11.9	0.02	10.4	140.7
Gallium	86%	186.1	0.81	1,666.9	2,706.7
Gold	9%	17,903.1	34,991.92	740,317.0	260,210.0
Indium	76%	149.2	59.47	25,753.9	1,981.6
Copper	2%	2.9	18.32	128.1	50.4
Lithium	n.n.	18.3	0.02	13.3	307.3
Palladium	16%	10,277.7	5,003.49	51,439.0	169,360.6
Platinum	11%	15,285.9	7,441.25	190,053.3	251,888.1
Ruthenium	80%	2,112.3	853.78	20,780.9	34,335.2
Steel	4%	1.7	0.43	10.0	25.6
Tin	1%	16.8	118.44	1,178.8	263.9

% SHARE
OF TOTAL USE OF MATERIAL WORLDWIDE THAT IS USED IN ELECTRICAL PRODUCTS

GOLD 17,903.1
PALLADIUM 10,277.7
PLATINUM 15,285.9
RUTHENIUM 2,112.3

CUMULATIVE GREENHOUSE EFFECT
TONNES OF CO2 EQUIVALENTS

LAND USE
SQUARE METERS PER TONNE
GOLD 34,991.92
PALL 5,003.49
PLAT 7,441.25
RUTH 118.44

GROSS ENERGY DEMAND
GJ/T
260,210
169,360
251,888
34,335
GOLD PALL PLAT RUTH
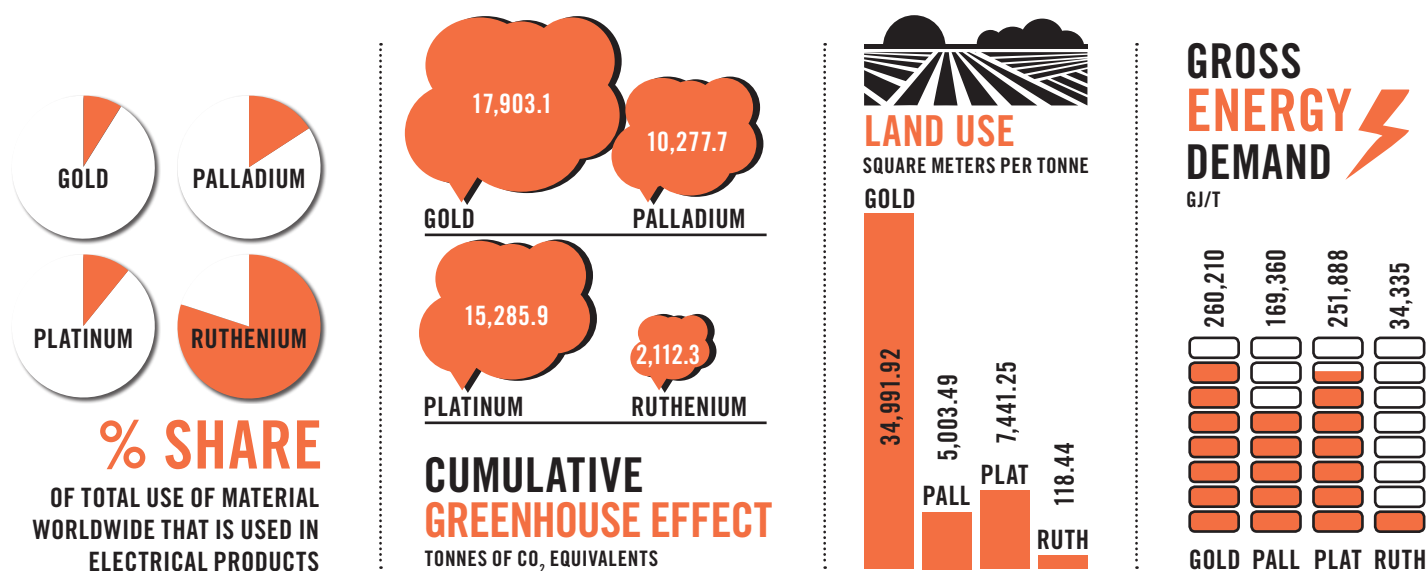
27 See e.g. http://ec.europa.eu/environment/resource_efficiency/targets_indicators/roadmap/index_en.htm.

28 Based on respective information on indicators from: Umweltbundesamt (2012): Indikatoren / Kennzahlen für den Rohstoffverbrauch im Rahmen der Nachhaltigkeitsdiskussion. Umweltforschungsplan des Bundesministeriums für Umwelt Naturschutz und Reaktorsicherheit. Institut für Energie- und Umweltforschung Heidelberg GmbH (ifeu) (20593368). Available online at http://www.umweltbundesamt.de/sites/default/files/medien/461/publikationen/4237.pdf, last accessed 6/16/2014, based on Ecoinvent 2.2 and own calculations by IFEU.

29 Appendix 6, Waste & Resources Action Programme (2012): Reducing the environmental and cost impacts of electrical products. Part 3: Methodology Report. With assistance of Kevin Lewis, Aida Cierco, Andrew Bodey, Xana Villa Garcia, Sam Matthews, Justin French-Brooks, Anthea Carter. Product Sustainability Forum. Available online at http://www.wrap.org.uk/content/reducing-environmental-and-cost-impacts-electrical-products, last accessed 6/13/2014.

The figures in this table show e.g. that to extract 1 tonne of gold, we need in total about 260,210 GJ of energy and land of approximately 35,000 m2 is used. The figures show that the resource impacts related to the pre-production of virgin materials are particularly high for some of the metals used in electronic products.

Against this background, the guiding parameter 'Raw Material Consumption' (RMC) was created, which also considers production chains in non-EU states.[30] The RMC was recently quantified for the first time for different fields of use in the EU 27.[31]

Figure 6: Raw material consumption (RMC) for various fields of use in the EU 27[32]
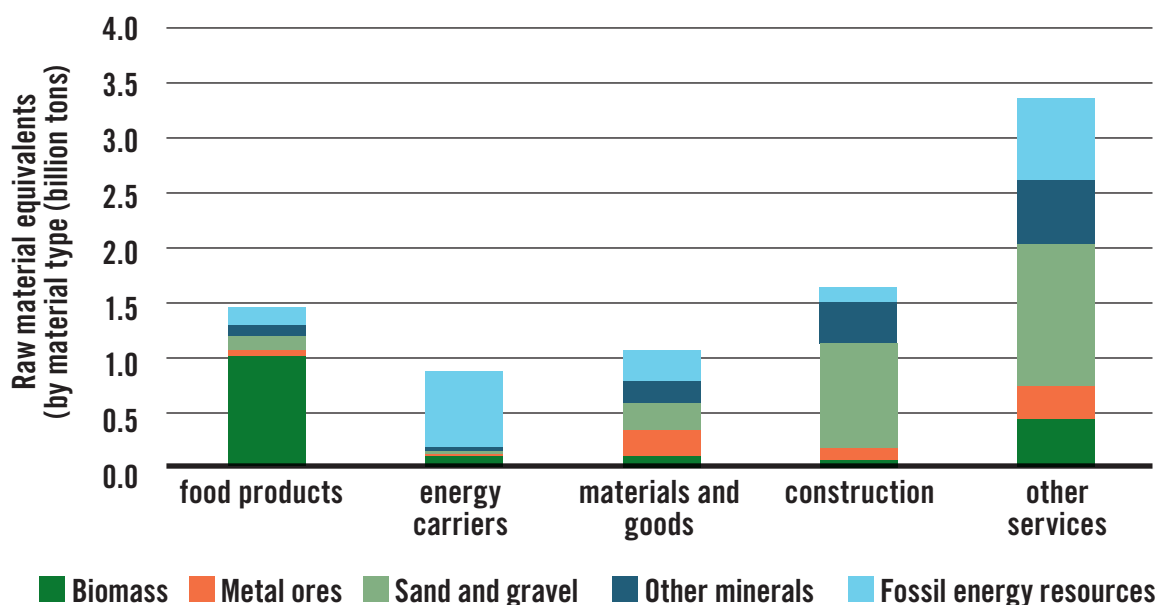
A large number of the product categories that could be addressed through product policy measures, are 'hidden' within the field of 'materials and goods', which is responsible for around 13% of total resource consumption. Beside some simple product types, complex electronic devices are also included here like laptops. They have a raw material consumption of 270 kg for every kilogramme of the final product's weight.

For an in-depth analysis of the resource consumption of single product groups, EU statistical systems so far lack the necessary linkages between sector-specific input-output tables and the actual diversity of products.[33]

An even greater methodological challenge in the discussion of resource impacts of products are the multiple dimensions of the debate on resources. DMC and RMC are purely mass-related indicators. However, for many materials, indicators other than the mass of raw material equivalents can lead to quite different prioritisations. The following graph illustrates this.

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[30] These activities put the respective announcements of the roadmap to a resource efficient Europe into practice.

[31] Cf. e.g.: Schoer, Karl; Weinzettel, Jan; Kovanda, Jan; Giegrich, Jürgen; Lauwigi, Christoph (2012): Raw material consumption of the European Union--concept, calculation method, and results. In Environ. Sci. Technol. 46 (16), pp. 8903–8909. DOI: 10.1021/es300434c.
Eurostat (2012): Conversion of European Product flows into raw material equivalents. Final report of the project: Assistance in the development and maintenance of Raw Material Equivalents conversion factors and calculation of RMC time series. Institut für Energie- und Umweltforschung Heidelberg GmbH (ifeu); Sustainable Solutions Germany (SSG); Environmental Center University Prague (1.1). Available online at http://fb4.ifeu.de/nachhaltigkeit/pdf/RME_EU27-Report-20120618.pdf, last accessed 9/16/2014.

[32] 'Construction and RES' (real estate services = services connected to buildings) include construction of buildings and streets as well as the connected services; 'other services' include retail, trade, repair, health, social work, hotels, restaurants, public administration and defense.

[33] Since these missing data and methods fundamentally prevent that the success of a resource policy can be tracked (among other things) using quantified indicators the members of the European Resource Efficiency Platform (EREP) repeatedly asked to accelerate these developments See (EREP) European Resource Efficiency Platform (2012): Manifesto & Policy Recommendations. Available online at http://ec.europa.eu/environment/resource_efficiency/documents/erep_manifesto_and_policy_recommendations_31-03-2014.pdf, last accessed 9/16/2014. Especially the section 'Action for a resource efficient Europe', First set of policy recommendations.

Figure 7: Impact on natural resource use of consumption and production of different materials based on respective indicators[34]

Legend:
- **Plastics**
- **Coal** (heating and electricity in housing)
- **Natural gas** (heating and electricity in housing)
- **Crude Oil** (heating and electricity in housing)
- **Biomass from forestry** (Wood, paper and board)
- **Animal products** (animal protein and fish)
- **Crops**
- **Iron and steel**
- **Other Metals** (Zinc, Lead, Nickel, Copper, Aluminium)
- **Minerals** (Glass, Salt, Concrete, Ceramics, Clay, Sand and Stone)

X-axis categories: Consumption by mass, Global Warming Potential, Land Use Competition, Human Toxicity, Environmentally weighted Material Consumption

It is clear that the natural resource use impact of energy-related products, which are largely composed of metallic compounds and plastics, would be grossly underestimated if only land use is taken into consideration. The opposite would be the case if examining a product's impact against an indicator of 'human toxicity'. Therefore any ranking of the impact of materials on natural resource use – and product groups from a resource conservation perspective – is determined by the decision of which natural resources to include in the analysis and which impact indicators are used.

Aggregating different indicators to one lead indicator would solve the problem. Yet there is no single truth, based on scientific facts, for such an aggregation. Any aggregation would require political decisions regarding the relative 'value' of different natural resources. Clearly, it would be very challenging to adopt a top-down approach which measures how important a single product group is for reducing the impact of European consumption and production patterns on natural resource use.

We need two things. On the one hand, we need a methodology which represents sector activities and products in statistical reporting systems. On the other, we need to prioritise about which natural resources need to be conserved over others.

[34] United Nations Environment Programme (2010): Assessing the Environmental Impacts of Consumption and Production. Priority Products and Materials. A Report of the Working Group on the Environmental Impacts of Products and Materials to the International Panel for Sustainable Resource Management. Available online at http://www.unep.fr/shared/publications/pdf/DTIx1262xPA-PriorityProductsAndMaterials_Report.pdf, last accessed 9/16/2014.

2.3 Assessing the impact of individual product groups on resource use – from the bottom up

While top-down analyses of the resource use of products remain rather difficult, assessing resource use in a bottom-up approach is far easier by looking at the manufacturing and use phases.

According to calculations for selected electrical and electronic devices, the products placed on the market within a year in the UK caused the equivalent of 200 million tonnes of CO_2 equivalents over their life cycle.[35] This amount can be broken down by product segment as follows:

Figure 8: Greenhouse gas emissions of different electrical product segment over life cycle (as share of total greenhouse gas emissions of all product segments over lifecycle)[36]
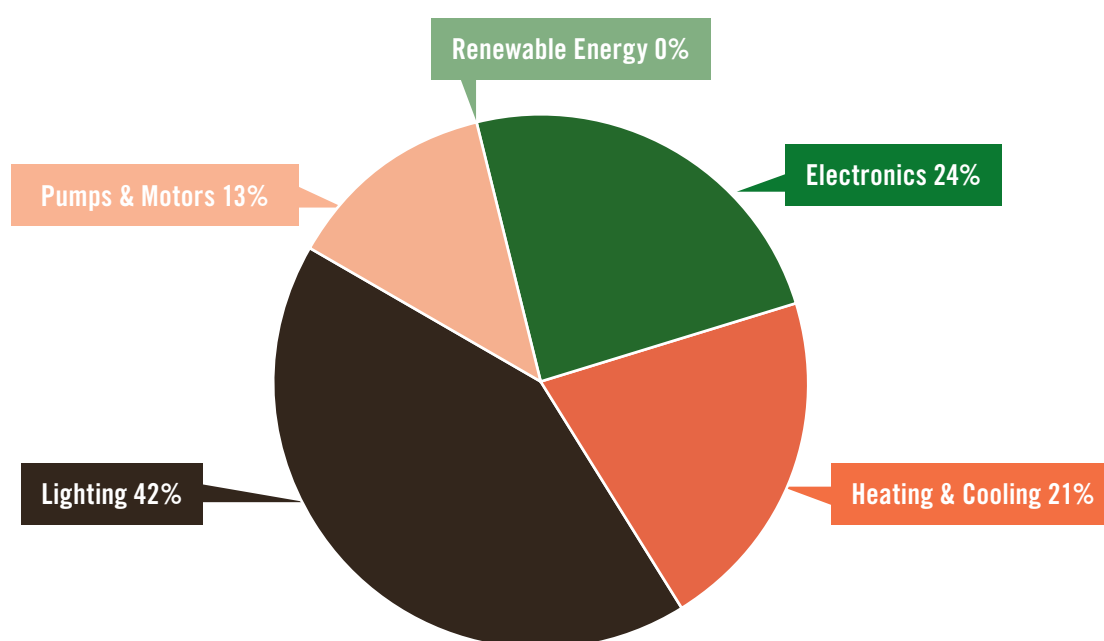
Upscaling the UK figure to the EU 28 corresponds to some 1,500 million tonnes of CO_2 equivalent emissions.[37] This is around the same amount of CO_2 equivalent emitted by all energy production in the UK, Germany and Poland together.[38]

The total material weight of the electrical products put on the UK market per year results in 1,400 million tonnes. Upscaling this figure to the EU 28 corresponds to some 10,000 million tonnes, or the equivalent of 250,000 fully loaded trucks. Looking at the share of each product segment based on total material weight produces a very different distribution compared to greenhouse gas emissions, as the next figure shows.

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[35] Waste & Resources Action Programme (2012): Reducing the environmental and cost impacts of electrical products. Part 3, p. 30,: Methodology Report. With assistance of Kevin Lewis, Aida Cierco, Andrew Bodey, Xana Villa Garcia, Sam Matthews, Justin French-Brooks, Anthea Carter. Product Sustainability Forum. Available online at http://www.wrap.org.uk/content/reducing-environmental-and-cost-impacts-electrical-products, last accessed 6/13/2014.
[36] Waste & Resources Action Programme (2012): Part 1, p 13.
[37] Results from such upscaling need to be considered carefully, because the market structure is different in different regions of Europe, but nevertheless the order of magnitude should be correct.
[38] This includes electricity al well as heat production in private and commercial sectors; UK = 482 Mt CO2-eq, DE = 786 Mt CO2-eq, PL = 319 Mt CO2-eq, ∑ 1587 Mt CO2-eq in 2012. Source: Eurostat, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_gge&lang=de.

Figure 9: Material weight of different electrical product segments (as share of the total weight of all products segments)[39]

Renewable Energy 1%
Pumps & Motors 8%
Lighting 2%
Electronics 39%
Heating & Cooling 50%
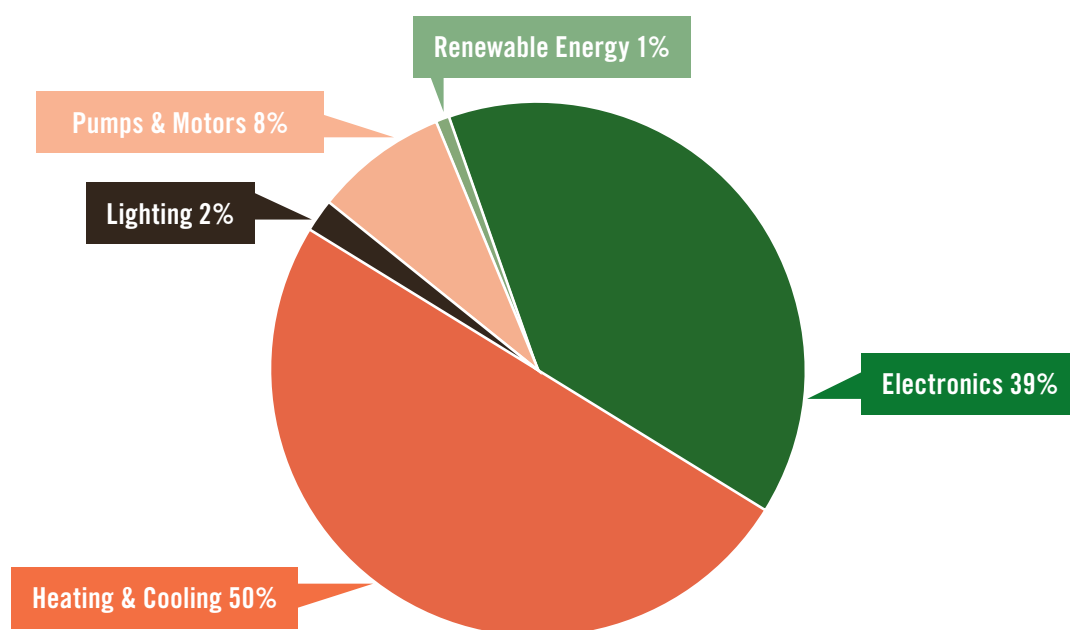
But as explained before the product weight only covers one aspect of the picture. If for example the greenhouse gas emissions from the pre-production of the materials contained in the products are used as an indicator for the 'embedded' impact on natural resources, the picture is somewhat different as the following figure shows.

Figure 10: Embedded greenhouse gas emissions of different electrical product segments (as share of the total embedded greenhouse gas emissions of all product segments)[40]

Renewable Energy 1%
Pumps & Motors 8%
Lighting 12%
Electronics 43%
Heating & Cooling 36%
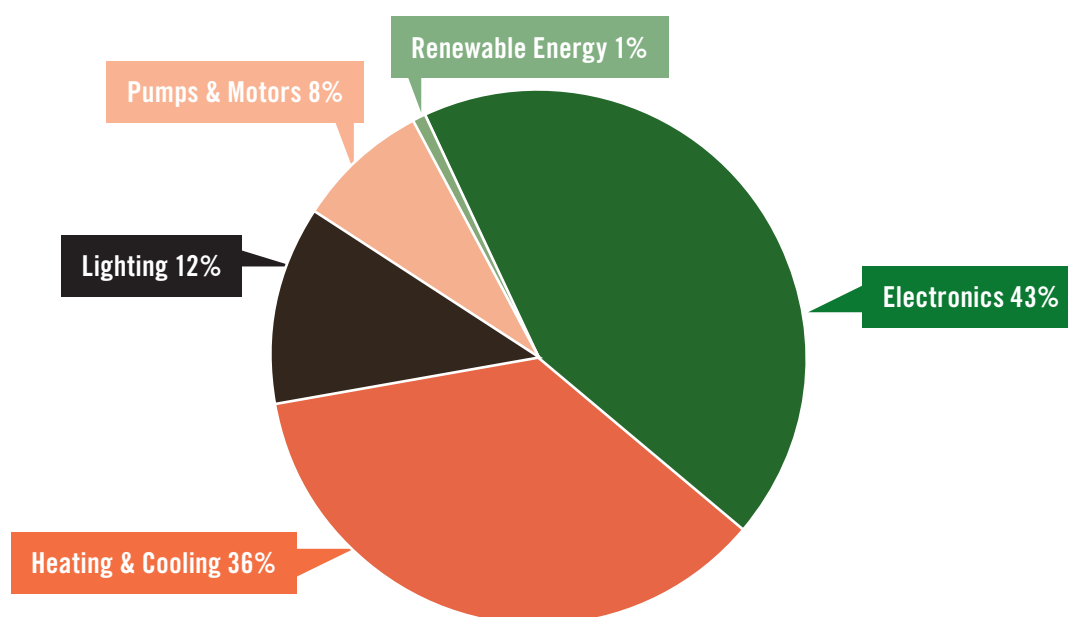
[39] Waste & Resources Action Programme (2012): Part 1, p. 13.
[40] Waste & Resources Action Programme (2012): Reducing the environmental and cost impacts of electrical products. Part 1: Results Report. With assistance of Kevin Lewis, Aida Cierco, Andrew Bodey, Xana Villa Garcia, Sam Matthews, Justin French-Brooks, Anthea Carter. Product Sustainability Forum. Available online at http://www.wrap.org.uk/content/reducing-environmental-and-cost-impacts-electrical-products, last accessed 6/13/2014, p. 17.

Because of the rare materials used and the high quality requirements for manufacturing processes, products with complex electronics have a far higher impact than simpler devices like those for heating and cooling.

Calculations for the UK show a total of 12.9 million tonnes of CO_2-eq emissions embedded in products, which projected to European level corresponds to a total of around 100 million tonnes of CO_2-eq emissions for the EU 28.

While the share of embedded greenhouse gas emissions amounts to 6.6% of the total life cycle emissions across all electrical products examined, the share for individual product groups is in some cases much higher. For example, for desk computers, embedded emissions account for 25% of lifecyle emissions, for microwaves the figure is 26%, and for laptops, the figure is as high as 50% of the total lifecycle emissions.

However, in setting priorities for individual product groups, both the share of greenhouse gas emissions embedded in a product and the number of products sold on the market should be taken into account.

The example of TVs illustrates this argument. Due to the high amount of energy they consume in the 'use' stage, TVs do not have a high share of CO_2 equivalent emissions embedded in them from the production phase.[41] However, because they are sold in high numbers, TVs represent 7% of all the greenhouse gas emissions embedded in electronic products under consideration. Other product groups that have a high share of the overall, embedded greenhouse gas emissions are vacuum cleaners and washing machines.

As already explained, the impact on natural resource use of a particular product type during the production or use stage differs according to the indicator used. The following analysis of a notebook[42] illustrates this clearly:

Figure 11: Impact of the different stages of a notebook lifecycle according to different indicators of resource use[43]
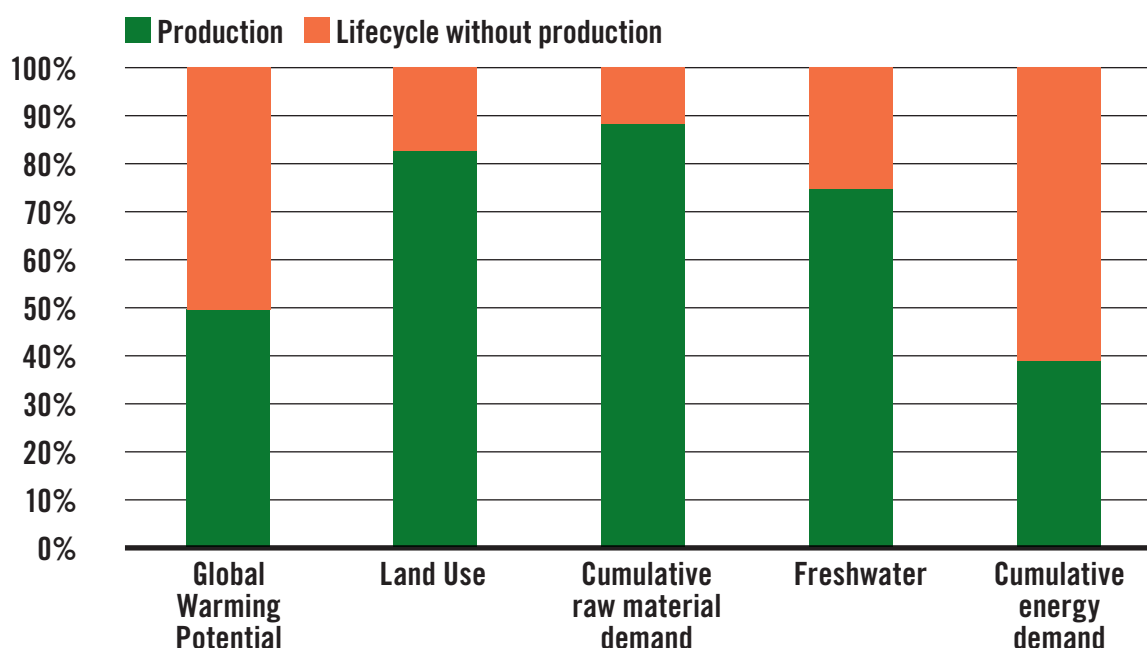
This example shows that if the use of natural resources like land and water are taken into consideration alongside more traditional indicators like greenhouse gas emissions, the materials used in a product and the production phase are key from a lifecycle perspective.

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[41] Although it should be noted that due to an improving in-use energy efficiency and more complex electronics contained in TVs, the share of impacts is increasingly shifting towards the production phase. This is also the case for many other electronics products, especially notebooks.

[42] Giegrich, Jürgen; Lauwigi, Christoph (August 2014): Produktbeispiel Notebook und Waschmaschine. Konzeption für eine Ressourcenverbrauchskennzeichnung für Produkte. Not published yet.

[43] Id.

2.4 Why product policy is essential for resource efficency strategies

In spite of the absence of sufficient statistical data, and of the inadequacy of indicators used in the EU for an in-depth analysis, it is clear that the production and use phases of products have an enormous impact on natural resource use. Targeted policy instruments stimulating changes to the patterns of production and use of products are therefore crucial for resource efficency and resource conservation strategies.

The impressive reductions in energy use, thanks to implementing measures and delegated acts under the Ecodesign and Energy Labelling Directives, provide an indication of what is also possible for resource use. Thanks to both directives, increased energy efficiency is expected to decrease Europe's energy dependence by saving as much as 66 million tonnes of oil equivalent as direct fuel savings and 465 terawatt hours of electricity per year in 2020, which represents in total 166 million tonnes of oil equivalent in primary energy.[44] That corresponds to the equivalent in CO_2 emissions of 7% of the EU total emissions in 2010, and is enough to offset the CO_2 equivalent emissions produced by 145 million cars[45] on the road per year. It will also deliver as much as 45% of Europe's 2020 energy savings target.

Aggregating the improvements for the devices that have legally binding implementing measures in place, which include among others boilers, fridges and washing machines, the net savings for EU households will total €110 billion every year from 2020, which represents €490 for every household annually. In addition, an extra revenue of €54 billion for industry and the retail sector is expected, as consumers will spend relatively more on acquisition costs while they spend much less on energy costs.[46]

With regard to resources, the materials contained in a product have an important impact on the 'embedded' greenhouse gas emissions. They have an even greater impact on the consumption of other natural resources such as fresh water or land use. A product policy that addresses these impacts in the same way as energy efficiency can deliver significant benefits.

No official assessment of the economic benefits from reducing resource use in products has yet been made from a bottom up perspective, as it exists for energy saving. This is due to the absence of any legally binding regulation in this area and of any impact assessment commissioned by regulatory authorities.

As regards top down assessments, existing research on the economic consequences of a more stringent resource efficiency policy does not differentiate between products related measures and their economic effects on the one hand and production or process related measures and economics on the other hand. That is, existing top down assessments do not specify in which life cycle stage the relevant effects occur.

Nevertheless, interesting figures are available from another source. The Ellen MacArthur Foundation has performed a series of studies over the last few years which assess the drivers and barriers to a circular economy. These assessments include case studies and sector analyses for different product sectors. The authors of the reports have delivered estimates about the economic effects from different circular economy scenarios. While the so-called advanced scenario includes several new business models from remanufacturing and other related activities, the transitional scenario includes the assumption that products are designed in a recyclable way – which they term 'circular design' – to the benefit of recycling companies.

In this transitional scenario, the Ellen MacArthur Foundation calculated net material savings of USD 340-380 billion[47] per year. Figure 12 highlights which sectors would benefit and what savings would be.

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[44] VHK, Ecodesign Impact Accounting, Part 1 (Status Nov. 2013), Delft, 30 May 2014, Report on behalf of the European Commission. Note that these figures include, besides Ecodesign and Energy Labelling, also the impact of the Energy Star programme and Tyre Labelling.

[45] Assuming that the average car drives 40 km per day, the annual emissions of 145 million cars are about 320 Mt CO2-eq. Source: https://www.atmosfair.de/kompensieren/wunschmenge.

[46] VHK, Ecodesign Impact Accounting, Part 1 (Status Nov. 2013), Delft, 30 May 2014, Report on behalf of the European Commission. Note that these figures include, besides Ecodesign and Energy Labelling, also the impact of the Energy Star programme and Tyre Labelling.

[48] Equal to about €270-300 billion/year.

Figure 12: Net material savings for different product groups in different circular economy scenarios[48]

520-630
(19-23%)

Net material cost savings in complex durables with medium lifespans
USD billion per year, based on current total input cost per sector, EU

340-380
(12-14%)

Motor vehicles

Machinery and equipment

Electrical machinery & apparatus

Other transport

Furniture

Radio, TV, and communication

Medical precision and optical equipment

Office machinery and computers

TRANSITION SCENARIO   **ADVANCED SCENARIO**

A more holistic policy aproach is necessary to cope with the multiple dimensions of resource conservation. This is essential in order to achieve absolute reductions, besides mere increases in efficiency, and to unlock the economic potential of circular material flows, which are necessary in a circular economy.

In the course of making products more resource efficient by design, it makes much sense to supplement this approach with new business models. For instance long-life products are especially suitable for leasing, which may create further economic benefits.

The mechanism by which product policy can address 'embedded natural resource use' and make the most of specific instruments is explained in the following chapters.

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[48] Ellen MacArthur Foundation, 'Towards the circular Economy – Accelerating the scale-up across global supply chains', 2014, p. 21.

3. ADDRESSING RESOURCE USE THROUGH DESIGN DECISIONS

3.1   How design influences the resource impact of products

Every phase in the life cycle of a product – from manufacturing and use to disposal – has an impact on resource use. The following figure illustrates this:

Figure 13: Resource impacts over the life cycle of products

Legend:
- Emissions
- Energy & Material
- Production phase
- Use phase
- Disposal/ reuse
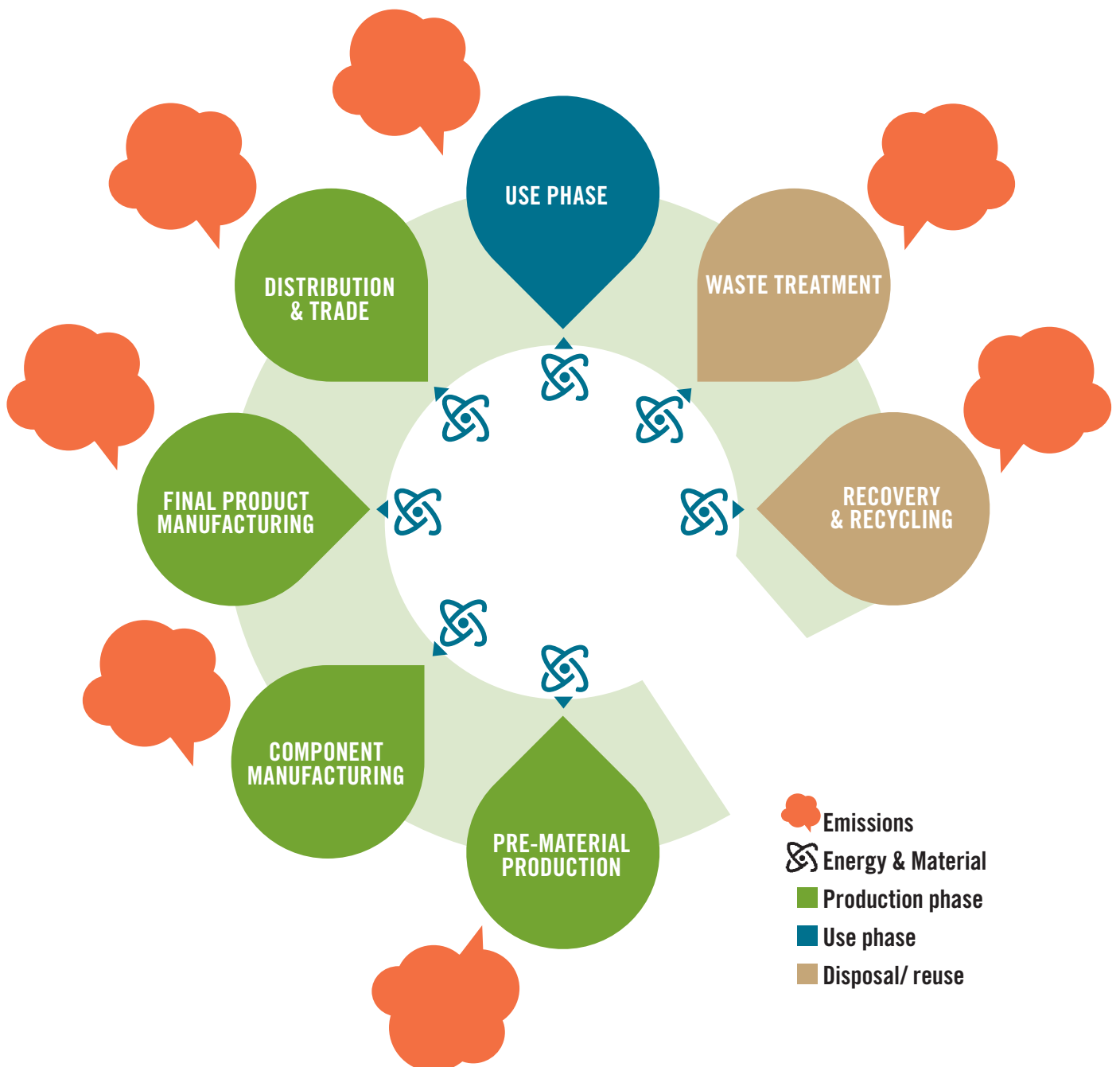
When designing a product, the resource impact is determined to a large extent[49] by defining product properties which also have an influence on the production chain processes, the use, and the possibilities for disposal. By taking ecological aspects during the design phase into account, the resource-related impacts of a product can be modified, as the following figure indicates:

Figure 14: Product design as a central point of control in the product life cycle
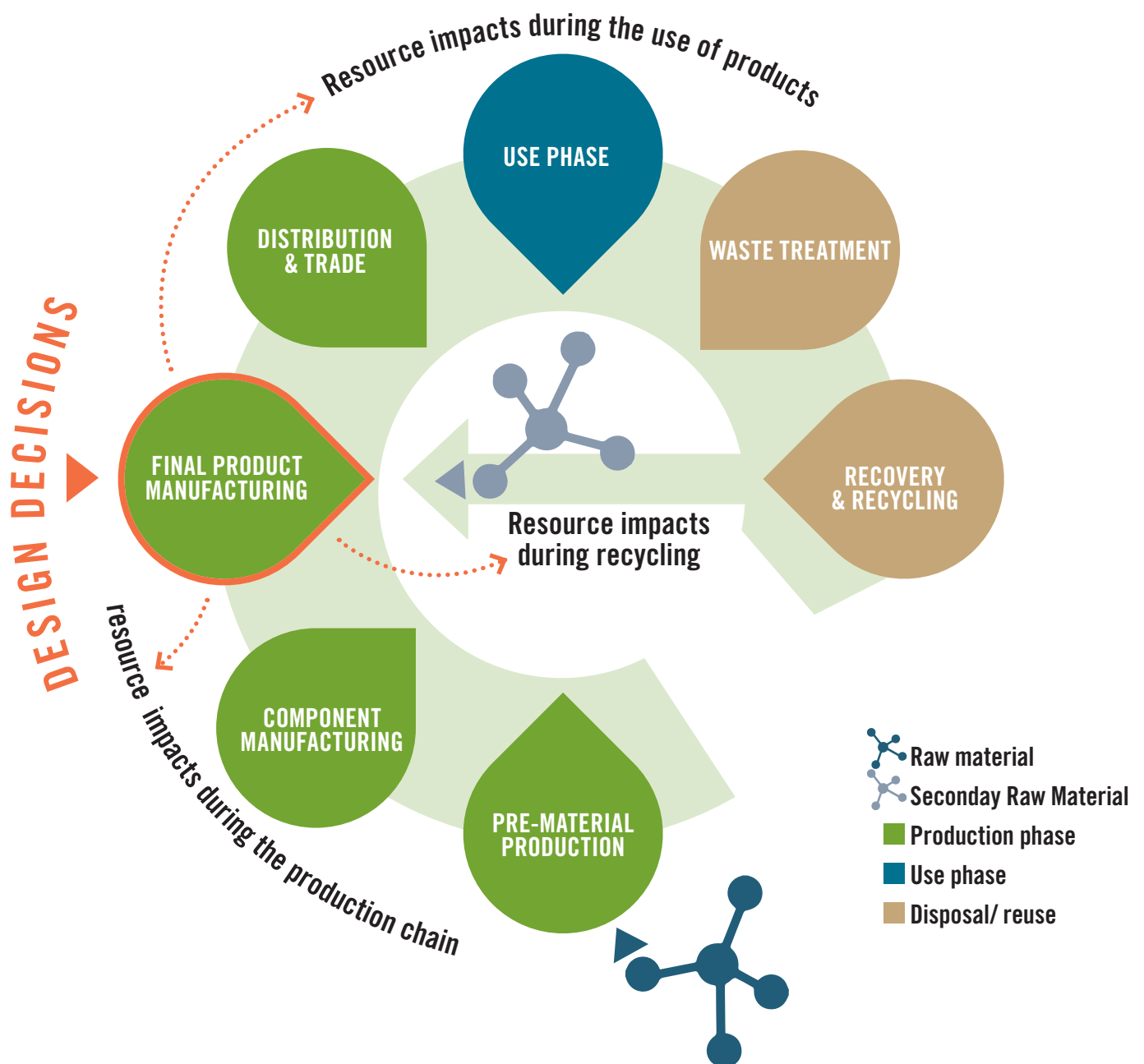
[49] According to some sources, this accounts for 60-80% of all environmental impacts.

However, a closer examination reveals that the design decision does not directly lead to resource impacts but instead determines the product's properties (materials used, specific ways of processing, energy demand).

Figure 15: Examples of product properties that are influenced by the (eco-) design decisions

DESIGN DECISIONS

PRODUCT PROPERTIES, E.G.

- Type of materials used
- Amount of materials used
- Production process (as far as defined by design)
- Hazardous substances in materials (as far as defined by design)

DESIGN SPECIFICATIONS

PRODUCT PROPERTIES, E.G.

- Energy use (in certain modes of use)
- Available functionalities
- Use of other consumables (in certain modes of use)
- Distribution and assembly of different materials within the product

The actual resource use takes place during the processes of manufacturing, distribution, use, maintenance, recycling and discarding of the product. So, aside from the design stage, the way these processes take place has an important influence on the overall resource use of a product.

To calculate the average impact of a product over its life cycle, assumptions about the 'normal' production processes, use patterns and end-of-life processes have to be made.

The following image shows this 'bridging function' between the production, use and end-of life processes of design decisions and the final environmental impact.

Figure 16: From design decisions to final environmental impacts

ENVIRONMENTAL IMPACT

DESIGN DECISIONS

ENVIRONMENTAL IMPACT

PRODUCTION PROCESSES

PRODUCT PROPERTIES

USE PROCESSES

ASSUMPTIONS REGARDING

- Transportation (means, distances)
- Processing (efficiency, emissions etc.)
- Extraction (efficiency, land use, emissions etc.)

ASSUMPTIONS REGARDING

- Way of use (intensity, frequency, duration)
- Willingness to repair
- Disposal (mono-fraction, mixed, etc.)
- Recovery and recycling (efficiency etc.)

The next examples show how the importance of production phase versus the use phase can differ depending on whether a product simple in production is used in a less efficent way or a more sophisticated product is used quite efficiently.

The first example represents the typical use pattern of a washing machine with a 5 kg load, with an average washing frequency, washing temperature, the average type of detergents used, and its average lifespan.[50] A lifecycle assement using this data and information on the composition of the washing machine leads to the following life cycle impacts for different resource use indicators. Here the use phase turns out to be the most important of all impact categories.

Figure 17: Distribution of life cycle impacts on the use and manufacturing phase for the 'normal' use pattern of a washing machine[51]
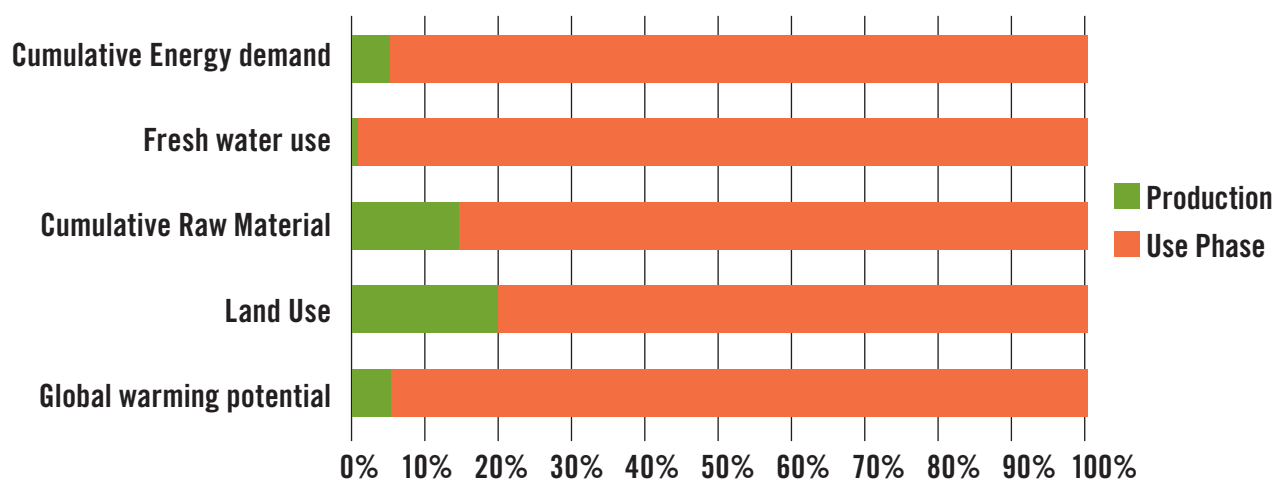
If instead a more complex modern washing mashine with e.g. a higher share of electronic and other sophisticated components, which allows for a less resource consuming use pattern with lower washing temperatures, more efficient detergents, and shorter washing cycles, is used, the results of the lifecycle assessment change significantly:

Figure 18: Distribution of life cycle impacts on the use and manufacturing phase for a washing machine using a high efficiency use pattern[52]

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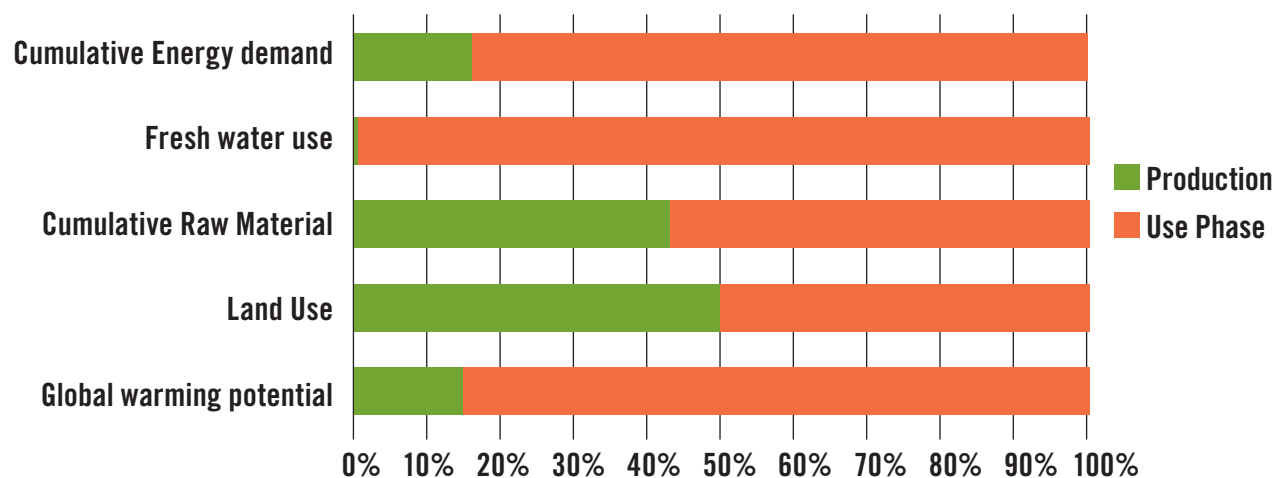
[50] Data from: European Commission (2007): LOT 14: Domestic Dishwashers & Washing Machines. Preparatory Studies for Eco-design Requirements of EuPs. ENEA; ISIS; University of Bonn.

[51] Giegrich, Jürgen; Lauwigi, Christoph (August 2014): Produktbeispiel Notebook und Waschmaschine. Konzeption für eine Ressourcenverbrauchskennzeichnung für Produkte. Not published.

[52] Giegrich, Jürgen; Lauwigi, Christoph (August 2014): Produktbeispiel Notebook und Waschmaschine. Konzeption für eine Ressourcenverbrauchskennzeichnung für Produkte. Not published.

While fresh water use is, for obvious reasons, clearly dominated by the use phase, for other resource use indicators, like cumulative raw material consumption or land use, the production and consumption phases are of a similar importance.

Two different conclusions can be drawn from this example. One is that the assumptions made regarding the use pattern of a new device is a very important factor for the overall lifecycle results, and relevant uncertainties exist here. Secondly, it is true for most energy using devices that the efforts made to increase the efficency during the customer use stage lead to an increased relevance of the production phase. This is due to the decreasing absolute impacts of the use phase, but in many cases as well due to the more complex composition of the product.

Thus, design decisions addressing resource efficiency aspects of the production phase are getting more and more important from a holistic perspective.

In the following sections, some more generic ecodesign possibilities which would allow for greater material efficiency and/or reduced resource use are highlighted and examples are given to illustrate the potential reduction in resource use.

3.2   Resource conservation potential of simple product design improvements

In order to find out how simple, well known design solutions (like the use of more durable parts, or the reduction of product weight) can lead to reductions in resource use for existing products, the Waste and Resources Action Programme (WRAP)[53] conducted a number of analyses in the UK for various product groups.

This included examining how existing technical solutions can
- save materials,
- use materials with a low resource impact,
- reduce energy consumption,
- and/or improve recyclability.

If one extrapolates the effects of decreasing resource impacts from these studies[54] to the EU market using the respective sales figures for the different product categories, this results in significant saving potentials in the EU, even for only a selection of product categories (cf. Table 2).

Table 2: Reduction in greenhouse gas emissions and product material input by means of simple and readily available design improvements of existing products (assessment of potential for the annual sales)[55]

Product	Sales in the EU[56] [Mio pieces/a]	GHG savings [t CO2-eq/a]	Product material savings [t/a]
Microwaves	13.9	20,807	NA in original study
LCD Televisions[57]	25.9	161,159	NA in original study
Washing machines	20.7	153,180	97,290
Tumble dryers[58]	3.7	775	259
Vacuum cleaners	45.0	39,620	9,025
Laptops	31.4	NA in original study	52,689
Refrigerators	14.3	26,419	15,903
Total		**401,960**	**175,167**

[53] WRAP (Waste & Resources Action Programme) was founded in the year 2000 as an independent non-profit organisation, see http://www.wrap.org.uk/content/about-wrap.

[54] Waste & Resources Action Programme: Electrical Product Design Reviews. http://www.wrap.org.uk/content/electrical-product-design-reviews, last accessed 18/11/2014.

[55] Own calculations based on WRAP.

[56] The market data is taken from various preparatory studies on Domestic and commercial ovens (Lot 22), Televisions (Lot 5), Domestic Dishwashers & Washing Machines (Lot 14), Laundry dryers (Lot 16), Vacuum Cleaners (Lot 17), Laptops (Lot 3) and Domestic Refrigerators & Freezers (Lot 13), which were completed between 2006 and 2011.

[57] According to a recent proposal aiming to amend the Ecodesign regulation for TVs, the European Commission estimates the annual TV sales in the EU to have increased to 60-62 million by 2011 (see http://www.eup-network.de/fileadmin/user_upload/141112_Electronic_Displays_CF_ExplanatoryNotes.pdf). In order to be consistent with the other (older) sales figures, this more recent figure is not used in the table above.

[58] The results for tumble driers are surprisingly small compared to other products – this is due to the lower number of sales per year and particularly to the small improvement potential estimated in the original study.

3.3 The potential of prolonging the use phase

Besides material and energy efficiency, the prolongation of a product's life span[59] is crucial for developing resource efficient products.

If products have a longer life span, or a lower risk of early failure, and can therefore be used longer by the same or another person, the resources required for their production are allocated to higher rates of use (washing cycles for example). In this way, the purchase of a replacement product (which would require additional resource input) can be postponed.

Over a time span of 50 years, it is estimated that concrete measures aiming to prolong a product's technical life time can have significant effects. The table below demonstrates this for the case of the UK:

Table 3: Assessment of GHG emissions reduction effects by prolonged lifetime of products[60]

Product	Annual sales in UK [million units]	typical product lifetime [years]	Extended lifetime [years]	Annual greenhouse gas savings per product [kg CO2-eq]	Annual greenhouse gas savings in UK if 10% of stock is changed to long-life products [t CO2-eq]
Laptop	5.7	3	5	15.2	25,800
Printer	3.5	3	5	11.0	11,600
Washing machine[61]	1.9	12	31	14.8	33,525

Significant savings are also possible for products other than energy using devices. For example, the same study concluded that if the life span of 10% of the sofas in UK households would be prolonged from 8 to 12.5 years, this change would result in annual reductions of the Global Warming Potential (GWP) of 11,600 tonnes of CO_2 equivalent.

A range of design options that aim to extend the life time of electrical appliances for the EU 27 market could lead to the following effects:

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[59] The technical lifetime is to be distinguished from the actual time of use, which can be shorter as consumers may dispose of a product before it fails, for instance because it is not fashionable any longer.

[60] Source: Downes, Jackie; Thomas, Bernie; Dunkerley, Carina; Walker, Howard (2011): Longer Product Lifetimes. Hg. v. Department for Environment, Food and Rural Affairs (defra). Environmental Resources Management (ERM). http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17047, last accessed 6/8/2014.

[61] Note that the assumed extended lifetime for the washing machine is rather high

Table 4: Annual resource conservation effects of prolonging the lifetime of products in the EU[62]

Product	Sales EU [Mio/a]	Annual green-house gas savings per product [kg CO2-eq/a]	Average annual green-house gas savings in EU if all sales were long-life products [t CO2-eq/a][63]	Savings in resource depletion per product [kg Sb-eq/a]	Annual savings in resource depletion in EU if all sales were long-life products [t Sb-eq/a]
Laptop	31.4	15.2	477,280	0.12	3,768
Printer	24.2	11.0	266,200	0.10	2,372
Washing machine	20.7	14.8	306,360	0.14	2,898
Total			**1,049,840**		**9,038**

PROLONGING **THE LIFETIME** OF A PRODUCT through feasible design options

=

+1MT PER YEAR **REDUCTION IN GHG EMISSIONS**   GHG   **477,000 CARS** OFF THE ROAD FOR ONE YEAR
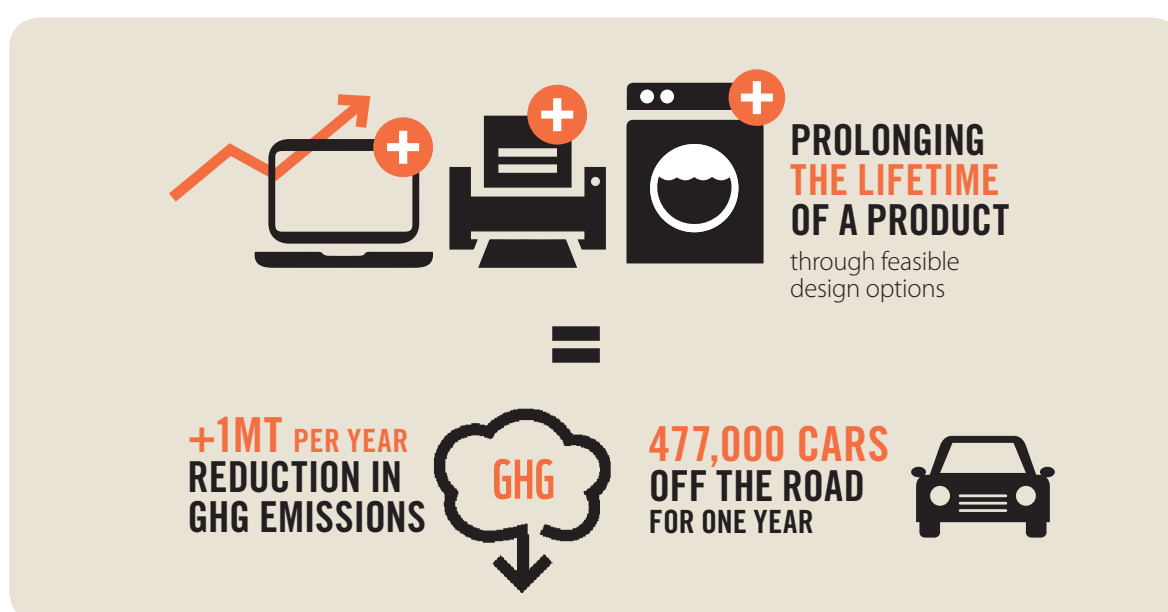
These figures suggest that the total Greenhouse Gas Emissions (GHG) saved from prolonging the lifetime of these products equal the GHG emissions of around 477,000 cars on the road for one year.[64] Material saving may be expressed in Antimony equivalents (Sb-eq). This is a weighted number which gives more importance to materials with lower worldwide reserves. If we take the savings on materials alone, these would correspond to the abiotic resource depletion of the exploitation of 650 tonnes gold annually.[65]

It is often stated that extending the life time of products may prove counter-productive. The argument runs that, since new devices are usually more efficient, the energy saved during the use phase would justify the additional resource use of manufacturing a new product.

Given that manufacturers raise this point in the interest of selling new products, it is important to analyse this issue in greater detail with some further calculations.

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[62] Calculation based on Downes, Jackie; Thomas, Bernie; Dunkerley, Carina; Walker, Howard (2011): Longer Product Lifetimes. Ed. by Department for Environment, Food and Rural Affairs (defra). Environmental Resources Management (ERM). http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17047, last accessed 06.08.2014. EU sales data taken from Ecodesign preparatory studies. See also previous table.
[63] Sb-eq = Antimony equivalents. See text for an explanation.
[64] Assuming that every car drives 40 km per day, the annual emissions of 477,000 cars are about 1 Mt CO2-eq. Source: https://www.atmosfair.de/kompensieren/wunschmenge.
[65] Calculated on the base of a similar overall resource depletion.

3.3.1 The washing machine example

In trying to test their newly developed index of longevity, the Joint Research Centre (JRC) of the European Commission published a methodology study[66] in which the effects of lifetime prolongation for two different types of washing machines are analysed. The first washing machine is the average model (WM1) and the second one is a model from a higher price segment (WM2).

In order to document the influence of the different parameters, such as the achieved life time extension, the potential energy savings of a new replacement product, and the amount of resources for the necessary repair and maintenance measures, the JRC carried out different scenario analyses. They included all life cycle stages and different environmental impact categories like Global Warming Potential (GWP), Terrestrial Ecotoxicity (TE) and Abiotic Depletion Potential Elements (ADP-el).

To display its results, the JRC developed a so-called Simplified Durability Index which expresses the advantage ('reduced environmental impact') of a prolonged product lifetime option[67] over the alternative throw-away-and-buy-new option.[68] The scenario analyses delivered interesting results.[69] Some of them are explained by the following graphs.

Figure 19: Assessment of the simplified durability index for the 'average' washing machine in terms of GWP

SIMPLIFIED DURABILITY INDEX FOR GWP (WM1)

Simplified Durability Index [%]

Energy consumption of the substituting product compared to WM1 as a %

■ 1 year ■ 2 years ■ 3 years ■ 4 years
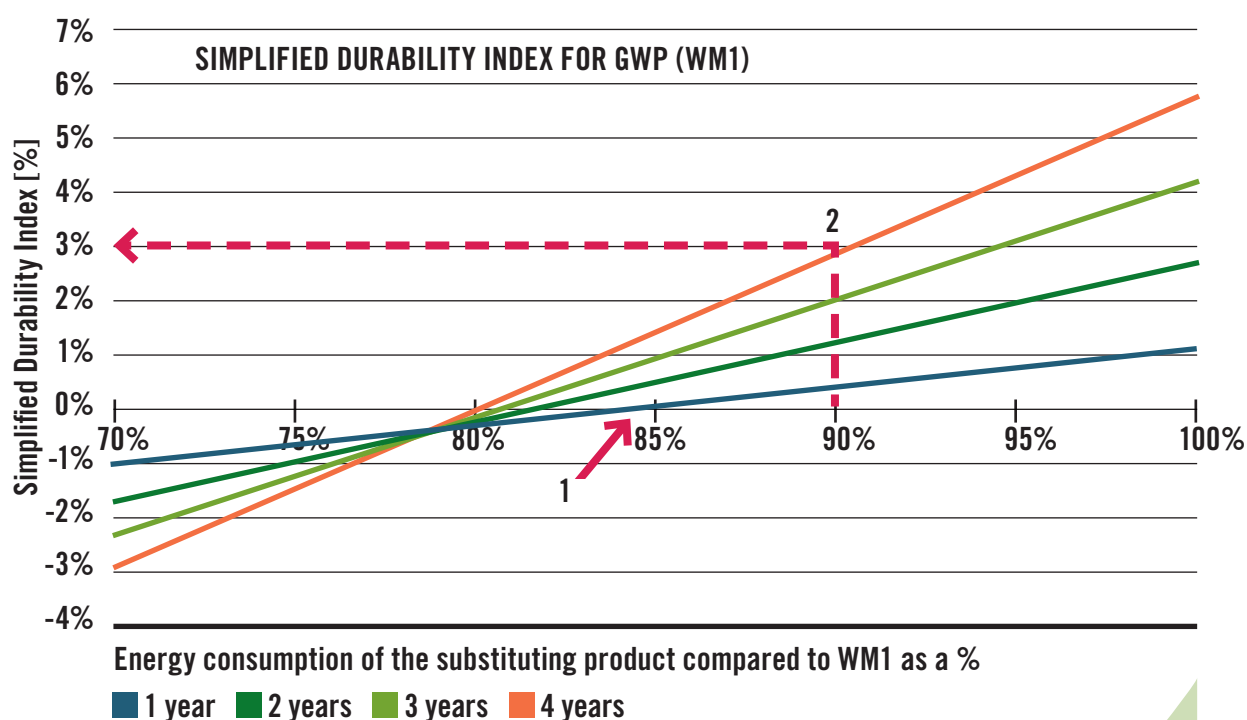
Explanation: Figure 19 shows
1. that if the lifetime of the old model can be prolonged for only one year a replacement model would need to be more than 15% more efficient to outweigh the overall reduction of CO_2-equivalent.
2. If the new model would be only 10% more efficient and the lifetime can be prolonged a clear positive effect (in terms of CO_2-eq) takes place.

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[67] Such option may either include the environmental burden from repairing/maintaining the product or respective efforts for improving the device before the first use phase already.

[68] Which takes into account the production of a new device including possible positive aspects such as a higher energy efficiency of the new model. Also the benefits from recycling/recovery the materials from thrown away products are considered.

[69] F. Ardente, F. Mathieux. Integration of resource efficiency and waste management criteria in European product policy – second phase; Report n° 1 Analyse of durability; November 2012, p. 35 ff.

If the same scenario analysis is performed for a more complex device (WM 2) which includes more electronic parts, the benefits on offer are even more impressive:

Figure 20: Assessment of the simplified durability index for a 'complex' washing machine in terms of GWP

SIMPLIFIED DURABILITY INDEX FOR GWP (WM2)

Simplified Durability Index [%] (y-axis)

Energy consumption of the substituting product compared to WM2 as a % (x-axis)

■ 1 year ■ 2 years ■ 3 years ■ 4 years
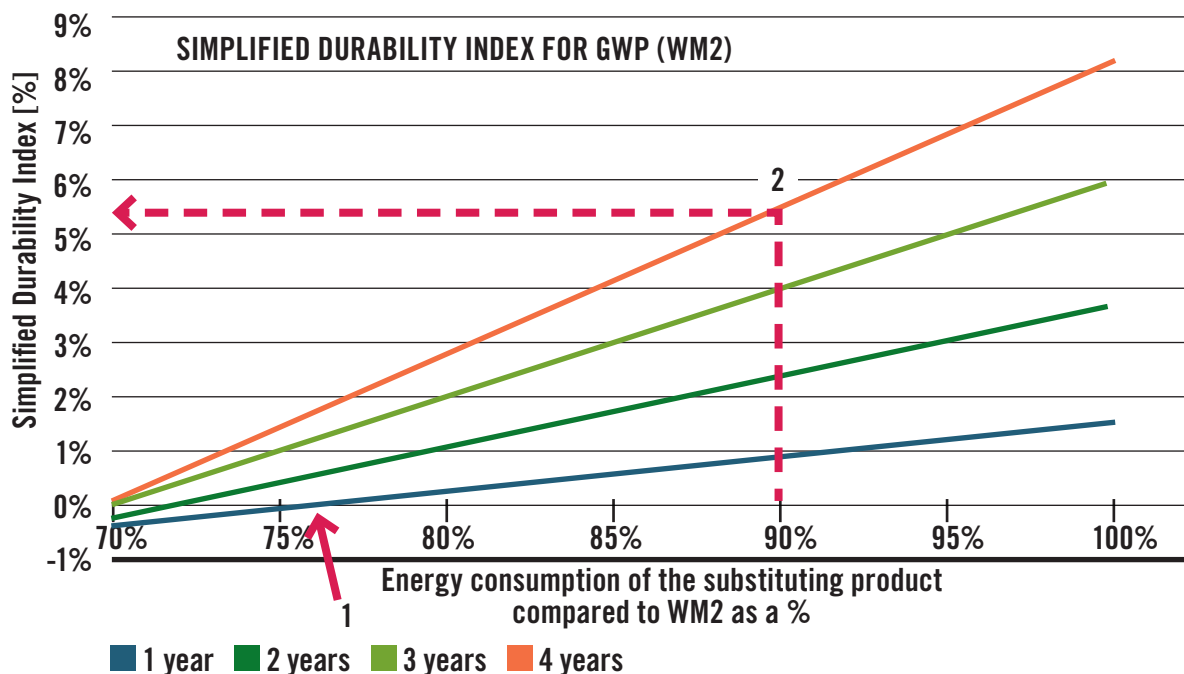
Explanation: Figure 20 shows
1. that if the lifetime of the old model can be prolonged for only one year a replacement model would need to be nearly 25% more efficient to outweigh the overall reduction of CO_2-eq.
2. If the new model would be only 10% more efficient the effect of the prolonged lifetime is much higher than for the 'average' device assessed before (Durability index 5.5% compared to 3%).

If the Abiotic Depletion Potential Elements (ADP-el) is considered, the picture changes. The ADP-el is more of a proxy for material consumption, so there are positive results independent from energy efficiency if the lifetime is extended beyond a certain minimum.[70]

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[70] Here this minimum is slightly more than a year.

Figure 21: Assessment of the simplified durability index for a 'complex' washing machine in terms of ADP-el

SIMPLIFIED DURABILITY INDEX FOR AB. DEPL. ELEMENTS (WM2)

Energy consumption of the substituting product
(compared with the case-study WM2)[%]

■ 1 year ■ 2 years ■ 3 years ■ 4 years
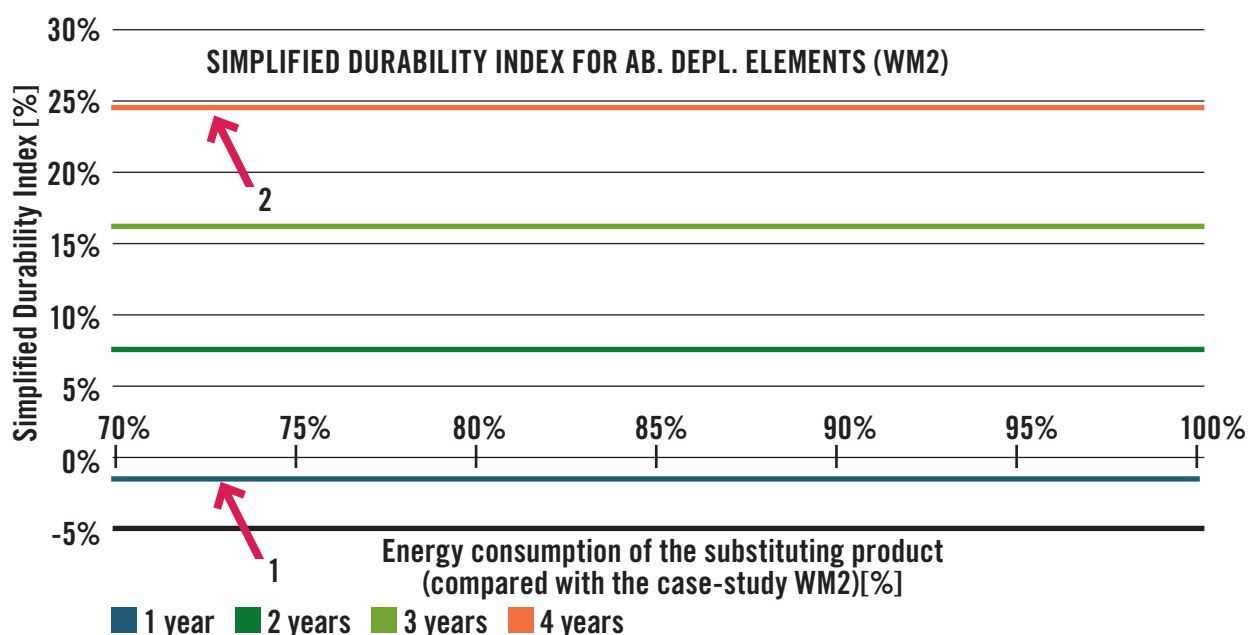
Explanation: This shows that

1. extending the machine's lifetime by only one year does not make up for the materials needed for repair/maintenance activity
2. if the lifetime can be prolonged by more than 2 years, the repairing/maintaining makes sense.

The different scenario analyses show that, for the majority of cases[71], extending a product's lifetime decreases its environmental impact. Based on these findings, the JRC study suggests starting points for evaluating which components and requirements could lead to an extension of the product's lifetime.

Better statistics and product tests are required to evaluate the components prone to failure.[72] According to WRAP assessments, the motor, pump, drum and control boards are crucial for determining how long a washing machine lasts.[73] Repair practices indicate that a number of small components, such as ball-bearings and gaskets of switches and pumps,

disproportionally contribute to the early failure of washing machines.

The JRC suggests establishing the following minimum requirements for these types of 'early-failure' components within the context of Ecodesign:

- minimum life times,
- non-destructive disassembly,
- long-standing availability of spare parts and
- significantly longer warranties.

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[71] This does especially not hold when a comparably inefficient machine could be exchanged by a highly efficient one.
[72] In addition, internet forums could deliver useful information.
[73] According to the 'Buying Specification Guides for Durability and Repair: Washing machines', see http://www.wrap.org.uk/content/buying-guides-durability-and-repair. Such guides are also available for four other product groups under this address.

3.3.2 The Notebook example

The German Federal Environment Agency (UBA) commissioned a research project[74] in 2009 from Öko-Institut and the Fraunhofer Institute for Reliability and Microintegration (IZM) to clarify the following questions:
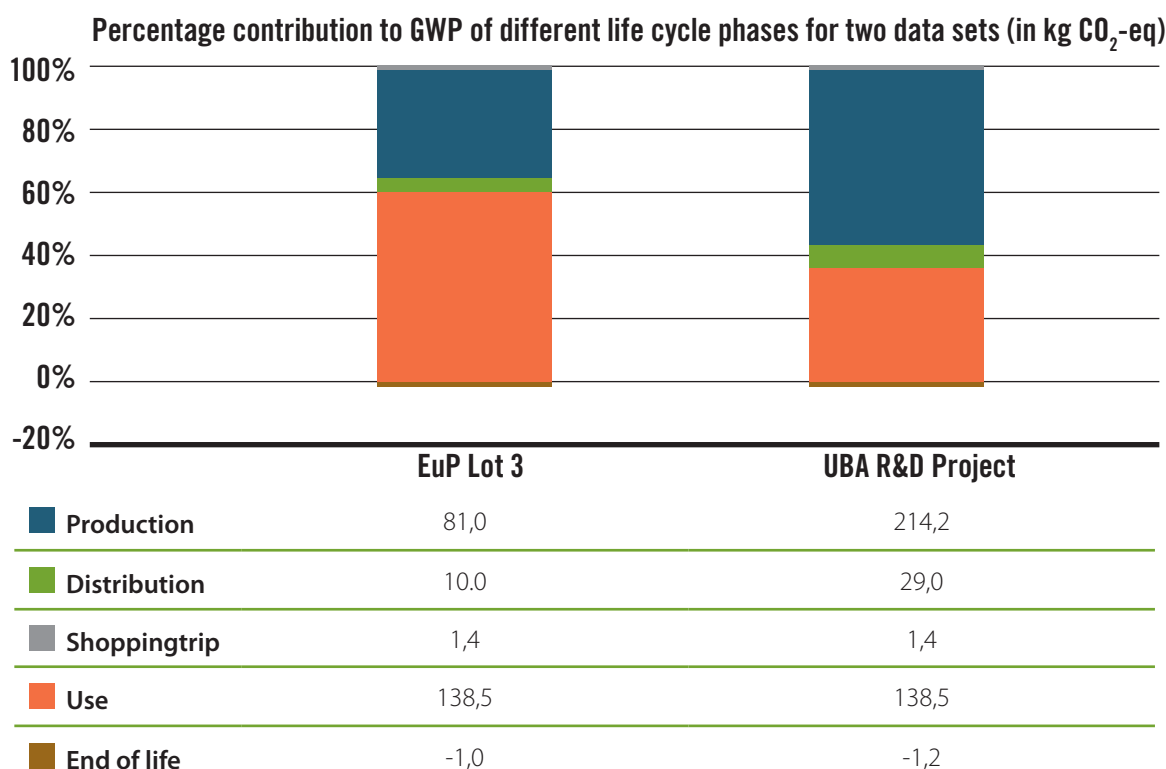
- What share of the total greenhouse gas emissions of a notebook can be assigned to the different stages of its life cycle?

- When is the optimal time to replace an old notebook with a new model in environmental terms – that is, when are the environmental impacts generated by the production, distribution and disposal of the new device compensated by the savings delivered by higher energy efficiency in the use phase?

- How much more energy efficient does the new notebook have to be for the replacement of the old and less efficient one to be justified from an environmental perspective?

In order to examine the impact of different data sources on the lifecycle assessments, the consultants for the study compared the data contained in the Ecodesign preparatory study on computers[75] ('EuP Lot 3') with a data set containing modifications of the Ecoinvent[76] data with new details regarding the manufacturing of basic electronic components ('UBA R&D Project'). The data sets were examined within similar production, use, and disposal scenarios.

The results from the analysis of these two data sets are displayed in the following graph:

Figure 22: Contributions of the life cycle stages of a notebook to global warming potential for two different data sets[77]

Percentage contribution to GWP of different life cycle phases for two data sets (in kg CO_2-eq)

	EuP Lot 3	UBA R&D Project
Production	81,0	214,2
Distribution	10.0	29,0
Shoppingtrip	1,4	1,4
Use	138,5	138,5
End of life	-1,0	-1,2

[74] Siddharth Prakash, Ran Liu, Karsten Schischke, Dr. Lutz Stobbe (2012): Timely replacement of a notebook under consideration of environmental aspects. Edited by Umweltbundesamt (UBA). Öko-Institut e.V., last accessed 9/16/2014.
[75] Jönbrink, Anna Karin (2007): Preparatory Studies for Ecodesign Requirements of EuPs - Personal Computers (desktops and laptops) and Computer Monitors. Final Report (Task 1-8). Industrial Research and Development Corporation (IVF). Mölndal, Sweden.
[76] Ecoinvent version 2.2.
[77] Amended figure based on Siddharth Prakash, Ran Liu, Karsten Schischke, Dr. Lutz Stobbe (2012): Timely replacement of a notebook under consideration of environmental aspects. Study on behalf of Umweltbundesamt (UBA), Öko-Institut e.V., last accessed 9/16/2014, p. 29.

While the absolute contribution of the use phase to the Global Warming Potential (GWP) is the same for both data sets, the absolute (and therefore, the relative) contributions of the manufacturing phase vary substantially (between 81 and 214 kg CO_2-eq in 5 years).

Since the own data set created for the study reflects recent and relevant data sources, it can be assumed that the real GWP contributions are in the range of the results of this data set rather than the 'EuP Lot 3' data set. An important reason for the differences in GWP contributions is that the production of electronic components often requires pre-materials and process additives of very high purity, which have

a high energy requirement for their manufacturing. These effects seem to be underestimated by the data included in the methodology underlying the 'EuP Lot 3' study and all other preparatory studies under the Ecodesign Directive.[78]

As explained before, the relation between energy consumption (or GWP contribution) in the use and manufacturing phases determines whether it makes sense to replace a product with a more energy efficient variant because of its environmental impact. Therefore, respective scenarios for amortisation were prepared in the case of the notebook and are displayed in Figure 23.

Figure 23: Amortisation periods for replacing a notebook using different scenarios and levels of energy efficiency improvements[79]
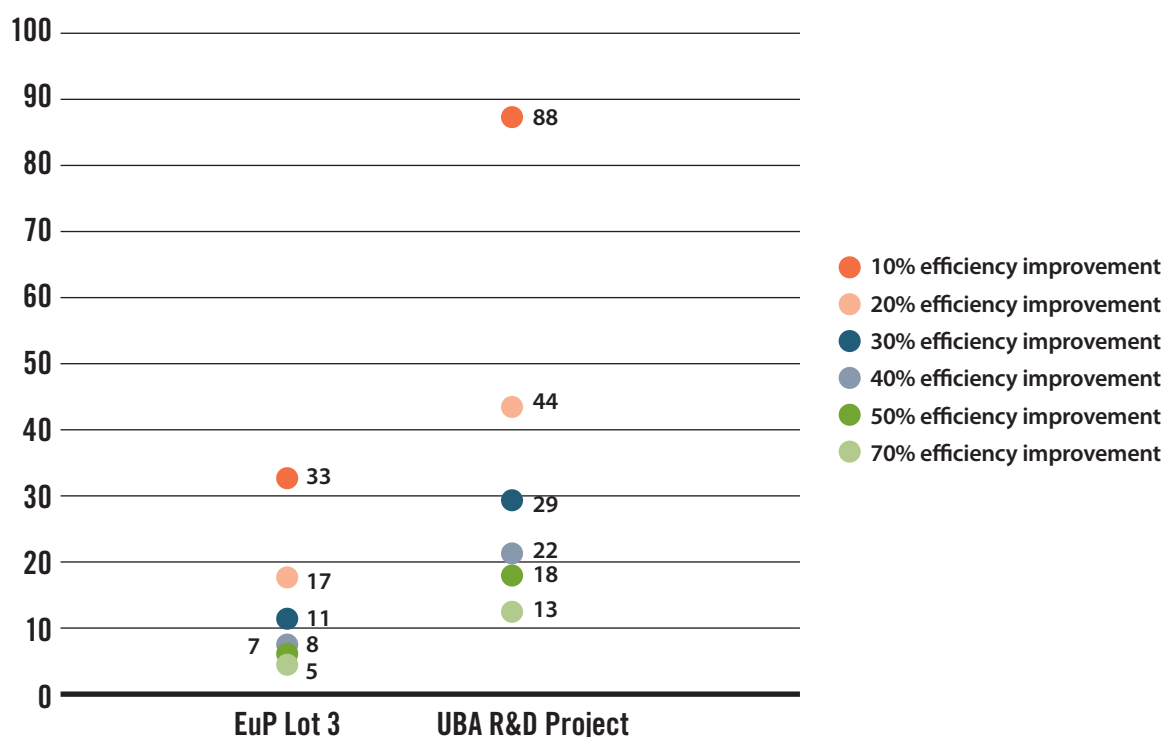
These results show that even for the scenario in which the GWP contribution of the use phase is highest, the environmental impact of replacing the notebook used for 5 years can only be amortised if the energy efficiency increased by an unrealistic 70%. The authors of the cited study assume real energy efficiency improvements between two notebook generations to be rather in the range of 10%.[80] This clearly demonstrates that the environmental impact of manufacturing a notebook is so high that it cannot be compensated by increases in energy efficiency.

On the other hand, the results clearly show that the relative contribution of the manufacturing phase to the overall greenhouse gas emissions is reduced significantly through the extension of a notebook's life time. The authors of the study thus conclude that aspects such as the possibility of upgrading, modular design, design for recycling, availability of spare parts, standardisation of components and minimum warranties should definitely be dealt with in the context of establishing minimum requirements for ICT products.

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[78] For this methodology, see chapter 5.1.
[79] Amended figure based on Siddharth Prakash, Ran Liu, Karsten Schischke, Dr. Lutz Stobbe (2012): Timely replacement of a notebook under consideration of environmental aspects. Study on behalf of Umweltbundesamt (UBA), Öko-Institut e.V., p. 33.
[80] Id., p. 48.

3.4   Using secondary material

Another approach for resource conservation that Ecodesign can address is the use of recycling material. Recycled content uses fewer natural resources, including energy, in its manufacturing than primary material.

The recycling of plastic, for example, saves up to 70 MJ (87%) of energy per kg of recycled matter by avoiding the production of new plastic from crude oil[81], and prevents up to 3 kg of CO_2 equivalent (74%).[82]

The same is true for metals sourced from recycled materials. The extraction of gold from electronic waste saves around 80% of GHG emissions compared to its extraction from ore.[83]

According to data on material contained in 8 product groups, 510,000 tonnes of plastics are used every year in the EU.[84] This is made up of 390,000 tonnes of simple bulk plastics, with the remaining 120,000 tonnes being specialised technical plastics. Assuming that the bulk plastics could be made of recycled plastics without loss of product functionality, this would lead to significant resource conservation, as the following numbers show.

Table 5: Avoided greenhouse gas emissions by using secondary material for selected product groups[85]

Share of secondary material (in bulk plastic parts)	20%	50%	100%
Avoided greenhouse gas emissions [t CO2-eq/year]	146,000	366,000	731,000

3.5   How design can boost recycling

In the process of designing a product, the product properties can also be determined in a way that they support the recyclability of components and the recovery of materials. In order to make the most of a product's resource conservation potential, products have to be taken to recycling plants at the end of their life.

Linking Ecodesign requirements for products on the one hand and disposal and waste treatment processes on the other therefore makes sense. There needs to be close interaction between Ecodesign requirements and waste regulation. For example, having requirements to remove Printed Circuit Boards (PCB) and Integrated Circuits (ICs) from discarded devices before they end up in the usual mechanical shredding processes would be a good solution.

Separate treatment and recycling of the PCBs and ICs allows for much higher recovery rates of the materials contained in components. It also increases their reuse levels in technical processes compared to situations when they are part of the larger waste stream and shredded along with the entire devices.

The following figure shows the effects of a separate treatment for the example of gold.

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81 This depends on the type of plastic and process used for recycling. The values of 30-70 MJ (54-87%) saving per kg of plastic are taken from the MEErP methodology (EU figures) (see chapter 5.1).
82 Average reductions of GHG emissions of 1 kg CO2-eq per kg of plastic (45%) can be assumed. Source: MEErP.
83 Hagelüken, Christian; Corti, Christopher W. (2010): Recycling of gold from electronics: Cost-effective use through 'Design for Recycling'. Gold Bull 43 (3), p. 209-220.
84 This figure is based on data from Ecodesign preparatory studies for the following products groups: washing machines, printers, copiers, desktop computers, notebooks, microwaves, household coffee machines, simple set-top boxes.
85 Product groups as named in the previous footnote.

Figure 24: Influence of different pre-treatment steps on the overall recovery of gold from circuit boards[86]

COLLECTION (COLLECTION RATE 50%)

MANUAL DISASSEMBLY (SPECIFIC)	MANUAL DISASSEMBLY (SIMPLE)	MECHANICAL TREATMENT (SPECIFIC)	LARGE SHREDDER (UNSPECIFIC)
97%	80%	75%	24%

METAL SEPERATOR/ SMELTER

95%

OVERALL RECOVERY RATE

46%	35%	33%	11%
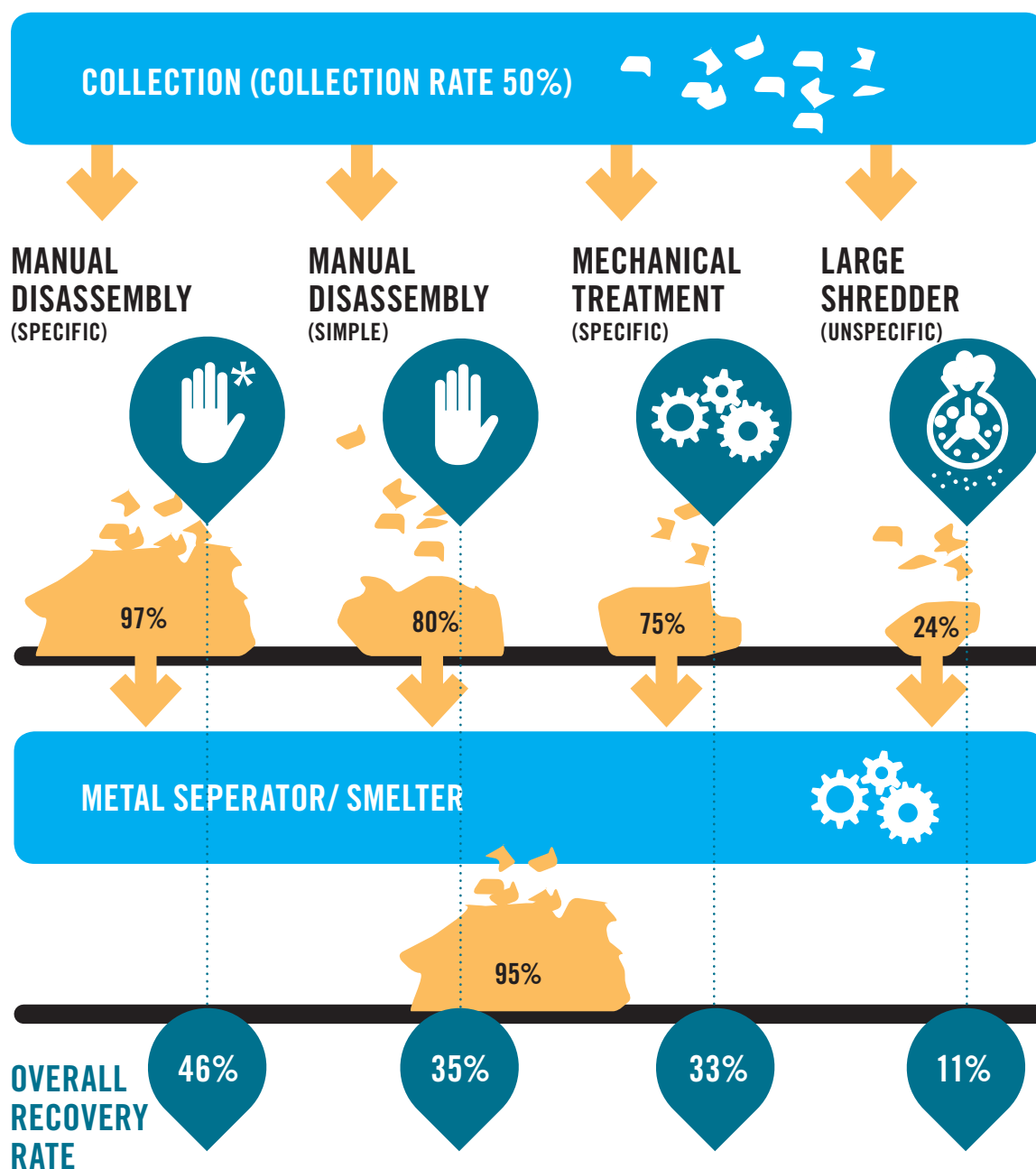
The efficiency rates presented in Figure 24 showcase that both manual pre-treatment (disassembly) and product group specific treatment processes (also mechanical ones) lead to much higher recovery rates than unspecific shredding and melting.

The JRC has analysed the resource conservation effects of manual pre-treatment[87] for circuit boards from washing machines in more detail. If the results from this analysis are transferred to a larger array of products which contain similar electronic components[88], this would have the following effects:

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[86] Based on Sander, Knut (2012): Schattenströme des Elektronikschrotts jenseits des Monitoring. VDI- Fachkonferenz Stoffliche und energetische Verwertung von Schredderrückständen. Ökopol GmbH. Nürnberg, 6/21/2012, edited with input of original author.

[87] Separation of PCB and some other components before shredding.

[88] This calculation is based on data from the Ecodesign preparatory studies for the following products: washing machines, microwaves, televisions (LCD-TV, PDP-TV & CRT-TV), desktop computers, laptops, flat panel monitors, coffee machines, simple and complex set-top boxes, printers, copiers.

Table 6: Resource conservation effects of a separate treatment of printed circuit boards from selected product groups

Resource impacts	
additional recycled mass of copper	1,295.47 t /a
additional recycled mass of silver	11.31 t /a
additional recycled mass of gold	1.71 t /a
additional recycled mass of palladium	0.51 t /a
additional recycled mass of platinum	0.11 t /a
Climate change	43,302.22 t CO2-eq/a
Ozone depletion	4.14 kg CFC11-eq/a[89]
Abiotic depletion elements	117.46 t Sb-eq/a
Abiotic depletion fossil	614.35 TJ/a

3.6 Conclusions on the resource conservation potential of product policy measures

Through specific and concerted design features/ requirements, resource use related to the manufacturing, use and recycling of products can be reduced. Concrete product examples indicate that beyond addressing energy consumption in the use phase, design features can also make contributions to resource conservation.

However, to date, very little of this potential has been seized. In order to change this, a clear political direction and objectives are needed. This could take the form of targets that go beyond pure efficiency increases, which may pay off economically in the

short term, and an aim to achieve an absolute reduction in the use of natural resources.

There are synergies between what is good for the economy and for the environment. Reducing raw material use leads to win-win situations for both areas and could bring about the necessary political impetus. However, the focus of resource conservation efforts should not be narrowed down to a handful of critical raw materials. Any political drive in this area should also address the decoupling of resource use from its environmental impacts.

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[89] Kg of chlorofluorocarbon-11 equivalents per year.

4. APPLICABILITY OF EXISTING PRODUCT POLICY INSTRUMENTS

4.1 The Ecodesign Directive as the core regulatory instrument

The Ecodesign Directive[90] is the core instrument of European environmental product policy. It establishes mandatory minimum requirements for product design and the accompanying product information. The requirements are applicable from the moment products are placed on the EU market and thus apply to products both produced within and imported into the EU. They are not retro-active. This means they do not affect products already placed on the market before the official entry into force of these minimum requirements.

Because of its character as a framework directive, the Ecodesign Directive becomes effective only through the establishment of mandatory Ecodesign requirements for specific product groups or of horizontal implementing measures.[91]

To date the main focus has been on energy efficiency requirements. However the legal framework does allow addressing other relevant environmental impacts over a product's life cycle. This can take the form of minimum requirements on product properties and/or information obligations related to them.

Excursus: Possibilities of the Ecodesign Directive with regard to addressing resource aspects

In Ecodesign implementing measures so far mainly the energy efficiency during the use of products has been addressed. According to the opinion of the European Parliament, this should be changed and also other aspects of products should be dealt with, in particular the efficient use of resources beyond energy, since only this way the whole life cycle of products can be considered adequately (cf. the documents of the recast procedure resulting in the current version of the Ecodesign Directive). Both from a methodological and legal point of view, this poses new challenges to establish such requirements because they are sometimes not or only with a significant effort verifiable on the product. Particularly environmental impacts resulting from processes far back in the production chain that do not leave traces in the product could be assigned to products only by requiring a documentation of the relevant processes.

The directive in principle addresses all significant environmental impacts of energy-related products over their entire life cycle. The possibility to include resource related aspects in the analysis of improvement options and finally to convert them into possible minimum requirements is therefore clearly contained in the directive, as the list of relevant ecodesign parameters in Annex I indicates, which form the basis for setting requirements:

Annex I Part 1 Ecodesign Directive:

1.1. In so far as they relate to product design, significant environmental aspects must be identified with reference to the following phases of the life cycle of the product:

(a) raw material selection and use; …

1.2. For each phase, the following environmental aspects must be assessed where relevant:

(a) predicted consumption of materials, of energy and of other resources such as fresh water; …

(e) possibilities for reuse, recycling and recovery of materials and/or of energy …

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[90] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of Ecodesign requirements for energy-related products. In Official Journal of the European Union L 285, pp. 10–35.
[91] Or, alternatively, through self-regulatory initiatives proposed by industry.

1.3. In particular, the following parameters must be used, as appropriate, and supplemented by others, where necessary, for evaluating the potential for improving the environmental aspects referred to in point 1.2:

(a) weight and volume of the product;

(b) use of materials issued from recycling activities;

(c) consumption of energy, water and other resources throughout the life cycle; …

(f) ease for reuse and recycling as expressed through: number of materials and components used, use of standard components, time necessary for disassembly, complexity of tools necessary for disassembly, use of component and material coding standards for the identification of components and materials suitable for reuse and recycling (including marking of plastic parts in accordance with ISO standards), use of easily recyclable materials, easy access to valuable and other recyclable components and materials; easy access to components and materials containing hazardous substances;

(g) incorporation of used components;

(h) avoidance of technical solutions detrimental to reuse and recycling of components and whole appliances;

(i) extension of lifetime as expressed through: minimum guaranteed lifetime, minimum time for availability of spare parts, modularity, upgradeability, reparability;

While the directive aims at increasing the level of protection of the environment in general (article 1 par. 2), it is also clear that the aspect of energy use has a certain priority. This becomes clear already in view of the scope ('energy-related products'), from the recitals (e.g. recital 14) as well as from article 1 laying out the increase of energy efficiency and security of the energy supply as a specific aim besides general environmental protection.

However, the recitals also emphasise the importance of resource efficiency besides energy efficiency (cf. recitals 3, 10, and 13). In addition, resource efficiency or resource consumption is mentioned in Annex I and in article 21a as relevant environmental parameters. Several of the references to resource efficiency found their way into the directive during the 2009 recast. This demonstrates the desire of the co-legislatures (EU Member States and EU Parliament) to address also not energy-related resource efficiency matters.

Thus the possibility to do so just needs to be implemented in a more meaningful and consistent way. This requires also to take into account the conditions formulated under article 15 (significant improvement potential in terms of environmental impact, no significant negative impact on consumers as regards affordability, no excessive administrative burden for manufacturers etc.). In this context especially article 15 par. 7 is of interest:

The requirements shall be formulated so as to ensure that market surveillance authorities can verify the conformity of the product with the requirements of the implementing measure. The implementing measure shall specify whether verification can be achieved directly on the product or on the basis of the technical documentation.

This paragraph seems to be crucial for the possibility to establish requirements related to the production process that cannot be verified on the product itself. The verification would have to be based on technical documents, which the manufacturer (or importer) has to provide. Such documentation could, for instance, contain third-party certification etc.; a mere self-declaration by the manufacturer would most likely not be sufficient from a legal perspective. Whether such requirements that are not verifiable on the product are a realistic option under real life conditions of market surveillance is however unclear.

4.2 Position and role of the Ecodesign Directive within product policy

The concept behind the Ecodesign directive is to prevent the worst performing products in environmental terms from gaining market access. A selective promotion of the frontrunners in the market is possible to a very limited extent through the provision of respective information.

But the Ecodesign Directive is only one of several instruments which, together, correspond to a push-pull approach in European product policy.[92] In principle, it is possible to include resource-related aspects into all of these different instruments as outlined in the following figure.

Figure 25: Possible interaction between product policy instruments

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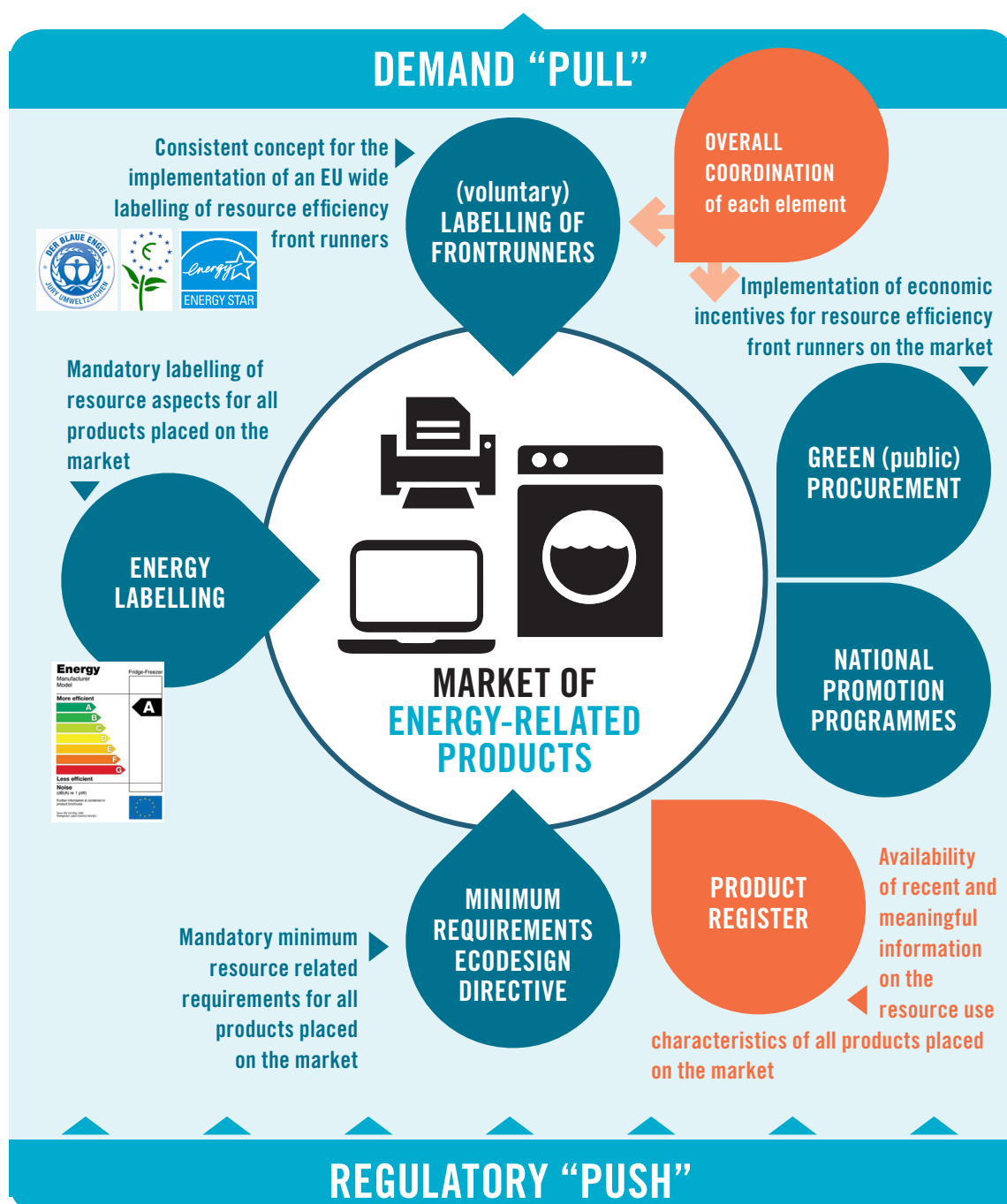
[92] This policy mix was outlined in particular in the Sustainable Consumption and Production (SCP) and Sustainable Industrial Policy Action Plan. COM(2008) 397 final, Brussels, 16.7.2008.

Up to now, resource aspects have only been considered in a few cases. Examples include adding durability or reparability requirements for selected product groups in existing Eco-Label schemes. But discussions on how to address resource aspects in a more comprehensive and consistent way in different policy instruments are ongoing.

Figure 25 features two additional aspects marked in red which are so far not part of the European product policy mix:

• A product register, which contains central resource-related information about the products placed on the EU market.[93] There could be an obligation to register products placed on the EU market within a general ('horizontal') information requirement for those product groups within the scope of existing Ecodesign and/or Energy label regulations.

• A stringent and transparent coordination of the different approaches to address resource efficiency across all instruments. This is true particularly for the methodology and even more so for the level of ambition.

Only with this coordination and the register would it be possible to link resource-relevant aspects of products to market information in basic statistical systems[94] and to generate real data concerning resource use in products.[95] Such registration systems are currently under discussion among those involved in the implementation process of the Ecodesign and Energy Labelling Directives.[96]

4.3 Strengths and weaknesses of the Ecodesign Directive as a policy instrument

The Ecodesign Directive could set minimum requirements for designing a resource efficient product and specify what information should be provided when it is sold. This would help make the use, re-use, repair or disposal of the device more resource-efficient.

A special feature of the Ecodesign Directive is its regulation of specific product groups. It does so by assessing the technical improvement possibilities for a particular product segment. Solutions without significant environmental improvement potential, excessive burdens to manufacturers or high costs to consumers are therefore unlikely to be considered.[97] Potential adverse impacts or trade-offs are usually anticipated and are addressed during the debates preceding the enactment of requirements. In addition, the process seeks to obtain the views of a wide set of relevant interest groups from the very beginning through to the final discussions and adoption of concrete regulatory proposals. In view of the complexity and multi-dimensionality of the resource conservation debate, it is important to adopt a pragmatic and effective approach to address resource related aspects in Ecodesign and to ensure transparency of the regulatory process from the beginning.

The current process of analysis and implementation under the Ecodesign Directive is inappropriate for defining generic targets concerning resource conservation. Nonetheless, the directive as such is predestined to translate such targets coming from other political processes[98] into concrete proposals for a specific part of the realm of products. The procedures established for the implementation of

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93 For a targeted development of pre-treatment facilities and respective attempts to collect specific discarded products separate it is e.g. very helpful to know how many devices from a product group contain critical raw materials and in which components these materials are located (product or recycling passport).

94 In particular the production and trade statistics.

95 It is an open question that requires further analysis whether it would be sufficient to register product models or if the number of units would be needed as well.

96 With respect to information on the energy efficiency (class) of the products placed on the market, such registration obligations are getting increasing support by some Member States and other stakeholders recently. It becomes increasingly clear that for any meaningful and realistic revision of efficiency targets it is simply a must to know how fast the markets are moving.

97 Even if the debate in the media with regard to Ecodesign requirements repeatedly claims such alleged bureaucratic malfunctions, this cannot be supported from a technical perspective. In addition, there exists often a surprisingly broad consensus among different stakeholder groups about the utility of the requirements, as evaluations of the policy have shown.

98 E.g. within the circular economy package or Europe 2020 or an overarching sustainable development strategy.

99 European Parliament; European Council (11/19/2008): Directive on waste and repealing certain Directives. Official Journal of the European Union L 312, p. 3. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&qid=1411115854791&from=EN, last accessed 9/19/2014.

100 Regulation (EC) No. 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

the Ecodesign Directive are in principle adequate to discuss the impact of product design on the use of natural resources or the possibilities to create a real circular economy. It also allows putting into practice the most important principles contained in the Waste Framework Directive[99], namely waste prevention, preparation for re-use, and recycling.

The WEEE Directive on waste electrical and electronic equipment (2012/19/EU) clearly states in its recital (11) and in Article 4 on product design that it needs to be enforced through Ecodesign implementing measures: "Ecodesign requirements facilitating the re-use, dismantling and recovery of WEEE should be laid down in the framework of measures implementing Directive 2009/125/EC. In order to optimise re-use and recovery through product design, the whole life cycle of the product should be taken into account." Further benefits can be gained by strengthening the links between energy and resource related aspects, both within the EU product policy framework and the proposals on the so-called Circular Economy Package. This

would facilitate a move towards a resource efficient economy and industry which is important for Europe's future prosperity.

Moreover, product group-specific rules in the Ecodesign Directive would help assess and reduce the risk of human and environmental exposure to the hazardous substances that are contained in products. The assessment procedure of specific product groups under the Ecodesign Directive makes information on the product's components and use patterns in the product life cycle available. Having these is necessary for assessing exposure risks and exposure levels. The possible substitution of hazardous substances could be carried out through this process.

This suggests that the Ecodesign Directive could also deliver substantial benefits in chemicals safety in the EU by complementing the substance-related approach of REACH[100].

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[99] European Parliament; European Council (11/19/2008): Directive on waste and repealing certain Directives. Official Journal of the European Union L 312, p. 3. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&qid=1411115854791&from=EN, last accessed 9/19/2014.
[100] Regulation (EC) No. 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

5. HOW TO ADRESS RESOURCE USE WITH THE CURRENT ECODESIGN DIRECTIVE

When addressing resource aspects within the Ecodesign Directive, two different levels have to be taken into account:

1) The methodology for studies preparing the creation of product-specific regulations under the directive, which is the main tool to analyse the environmental impacts and related (technical) improvement potentials for a specific product group or horizontal issue, and

2) Within the possible information, generic or specific (design) requirements that can be established in implementing measures.

The following sections will discuss both levels accordingly.

5.1   Is the methodology used for the product group assessments adequate?

5.1.1   The standard assessment methodology for preparatory studies

Assessing whether a product group is suitable for Ecodesign measures relies on specific preparatory studies for a product group. The European Commission developed a standard methodology which has been in use since 2005 (the so-called MEErP[101]) to analyse environmental aspects of different product groups and to assess the effects of different potential Ecodesign options.

The identification of environmental 'hot spots' and evaluation of possible technical improvement options through preparatory studies are usually based on one or several reference products ('base cases'), which represent the current situation of the product group in question. In relation to these base cases, different Ecodesign options are assessed by looking at improvements to the product's characteristics.

Within this process, the so-called EcoReport tool is used as a simplified lifecycle analysis (LCA). This is an IT tool which was developed specifically for the Ecodesign methodology. It allows the user to feed in crucial data on the composition ('bill of material') and the energy use ('use scenario') of the reference products. It then produces results for several impact categories based on LCA data sets that make up background data in the tool.

5.1.2   Possibilities and limitations of resource use considerations

For the resource impacts that are not triggered by energy consumption during the use phase, the Ecodesign methodology and EcoReport tool had limited value in the beginning. However, thanks to several studies[102], the methodology and tool were modified and expanded twice, allowing new

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101 'Methodology for the Ecodesign of Energy-related Products (MEErP)', various documents available under http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/methodology/index_en.htm, last accessed 19/09/14.

102 Study on behalf of DG Energy: 'Technical assistance for a material-efficiency Ecodesign report and module to the Methodology for the Ecodesign of Energy-related Products (MEErP)' December 2011. Various documents, see http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/methodology/index_en.htm;
Ardente, Fulvio; Mathieux, Fabrice; Forner, Javier Sanfélix (2012): Integration of resource efficiency and waste management criteria in the implementing measures under the Ecodesign Directive / in European product policies. First / second phase. Joint Research Centre (JRC Technical Reports).
Study on behalf of DG Enterprise: 'Technical assistance for a material-efficiency Ecodesign report and module to the Methodology for the Ecodesign of Energy-related Products (MEErP)', December 2013, Methodology additions with various documents published at http://meerp-material.eu/.

elements that could assess resource use to be added[103]. Among these elements is the possibility of feeding in specific lifecycle data sets. For some material types, such as paper and some plastics, various kinds of recycled material are included in the data sets, making it possible to directly analyse what the impact of using them would be. It is also possible to vary the expected recycling rates of the materials contained in the products and assess the product's environmental impacts using the so-called Recycling Benefit Ratio (RBR). The different technical life times of products can be assessed and compared with each other directly using this tool.

To assess the 'environmental quality' of the materials used in a certain product the energy required for their production and the related emissions can now be calculated. In addition to that the abiotic resource depletion is provided as standard information for these materials. Other important resource indicators, such as land use or the impacts on biodiversity, however, are still missing from the standard Ecodesign analysis.

In its current form, the MEErP is in principle suitable to identify non energy-related aspects and to assess the effects of different Ecodesign options.

In order to address resource aspects comprehensively, adding the environmentally important impact categories of land use and biodiversity loss would be preferable. This would require the development of an adequate methodology and to add the necessary lifecycle data but would not require any fundamental changes to the general setup of the MEErP and the Ecoreport tool.

In order to draw up conclusions on the different Ecodesign options, it is important to have more detailed resource conservation targets either for different materials or related environmental impacts of particular concern. E.g. by using a distance-

to-target approach, priorities can then be set for systematic and multidimensional optimisation. In absence of such politically defined targets for resource conservation, it is no wonder why energy efficiency and greenhouse gas emissions – those aspects which have been quantified – dominate the Ecodesign agenda so far.

Despite the absence of better indicators for measuring resource conservation, a pragmatic approach could unlock significant savings in current production and consumption patterns. This approach is needed in the short-term to address the urgent problem of resource depletion.

5.1.3 Approaches to overcome current challenges

In the following, some of the pragmatic ways for going forward are introduced.

Pragmatic approach A – Relate to relative improvement

One possibility is to limit the assessment to a core set of impact indicators and to push for 'relative' improvements and the 'best overall solution'.

This would fit quite well with the intention of the Ecodesign Directive which, as a push instrument, tries to ban the worst performing products from the market.

One design option would have to lead to substantial resource improvements for at least one of the core impact indicators, without leading to (significant) disadvantages for any of the other indicators. This is more easily understandable when illustrated with a graphic illustration. Figure 26 shows a proposal for a so-called 'resource compass', which features four central indicators to assess resource use.

The technical option that is to be evaluated (blue) is

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[103] Regarding details of changes proposed and implemented into the MEErP see respective information on: http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/methodology/index_en.htm.

Figure 26: Comparison of technical product variants applying a multi-dimensional product compass[104]
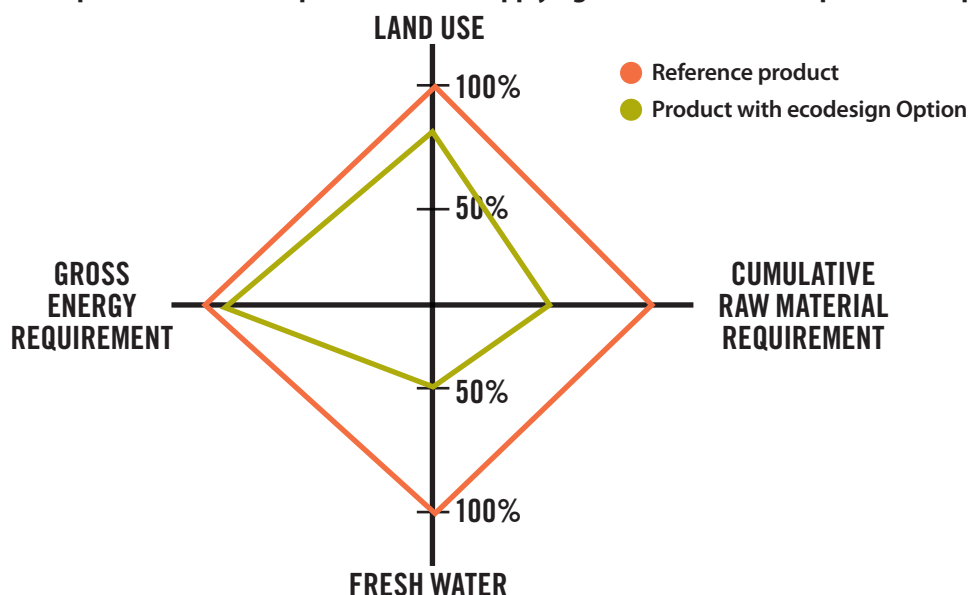
better than the reference product (green) for all four indicators.

This approach has the following characteristics and limitations:

- The selection of the reference product and its use scenario has a strong influence on the potential 'room for optimisation'. But this is the same as for energy efficiency assessments performed under the Ecodesign directive over the past eight years.
- Technical options that lead to improvements in one or several dimensions, but increase the burden in at least one other dimension, should not be taken into account.
  This limitation might make it difficult to find the best overall solutions but is suitable for identifying the worst products and ban them from the market.
- The quality of the available basic data for the different resource indicators today is of variable quality. However, the data only needs to be robust enough to identify relevant differences. This would be the case most of the time.

Overall, the pragmatic assessment rule proposed seems to fit with the purpose of the regulatory activities intended. This pragmatic assessment rule should only be used for the comparison of basis Ecodesign options on a generic level of preparatory studies.

Pragmatic approach B – Focus on selected materials

Another possible approach is to better focus the product group analysis and to simplify regulatory measures by selecting a limited set of resource-relevant materials. Those should be managed with particular care within a lifetime perspective in the context of product policy measures.

Adopting this approach is backed by several basic considerations:

- It can be directly linked to the concept of 'critical raw materials'[105], which has achieved a high level of acceptance among involved parties from both industry and politics;
- Since critical raw materials have been included in recent amendments to the standard methodology for preparatory studies (MEErP), this approach of prioritising materials is in principle already considered in the methodology;[106]
- It is in line with the regulatory approach of the Ecodesign Directive, which aims at removing from the market the products that perform worst;
- It accommodates the fact that the greatest challenge for resource-related product standards is not the analysis of environmental hotspots of a product, but the establishment of clear and enforceable requirements.

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[104] Adapted from Giegrich, Jürgen; Lauwigi, Christoph (August 2014): Produktbeispiel Notebook und Waschmaschine. Konzeption für eine Ressourcenverbrauchskennzeichnung für Produkte. Not published.

[105] These include materials that have been defined in a list in the report: European Commission (2010): Critical raw materials for the EU. Report of the Ad-hoc Working Group on defining critical raw materials. Available online at http://ec.europa.eu/DocsRoom/documents/5662/attachments/1/translations/en/renditions/pdf, last accessed 9/19/2014.

[106] Also if new methodological questions arise in terms of finding a common characterisation factor (so far antimony equivalents).

In order to identify the 'resource critical' materials, the 'criticality matrix' approach can be used (see Figure 27). It was developed in the context of securing Europe's supply with crucial technology raw materials[107].

Figure 27: Criticality matrix of the political debate on raw material supply[108]
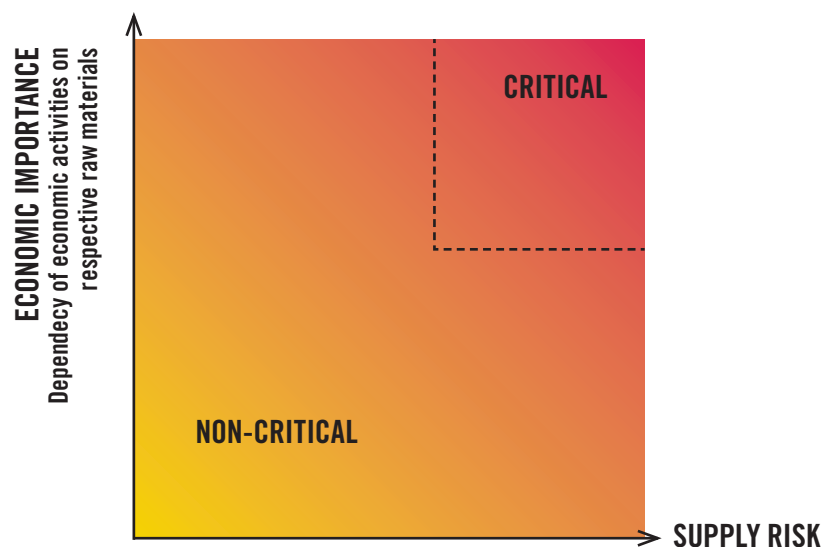
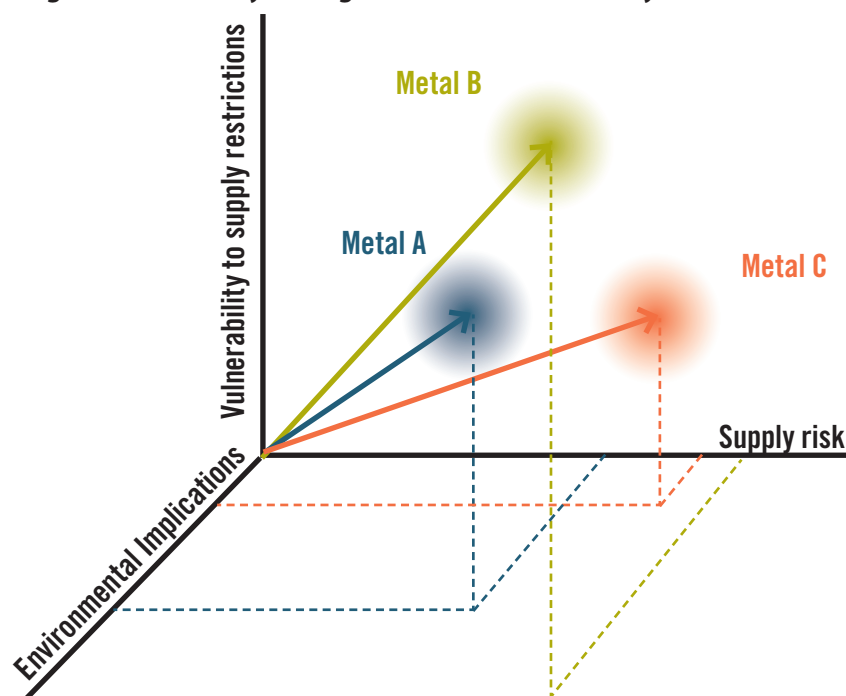The environmental impacts or risks may be considered as a third dimension. So the relevance of different raw materials can be assessed against three dimensions (see Figure 28).

Figure 28: Possibility to integrate an additional criticality dimension[109]

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[107] For instance in the context of the European Commission's Raw Materials Initiative: The raw materials initiative — meeting our critical needs for growth and jobs in Europe, Brussels, 4.11.2008., see http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0699:FIN:en:PDF

[108] Adapted from Tercero Espinoza, Luis A. (2013): Kritische Rohstoffe in der EU. Bewertungsgrundlagen. Integration von Materialeffizienzaspekten in die Umsetzung der Ökodesign Richtlinie. Fraunhofer ISI. Berlin, 11/19/2013. http://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Tercero_Oekodesign_Materialeffizienz.pdf?PHPSESSID=96ce841abeff0b1e23ad1b1e6490ec3c, last accessed 9/19/2014.

[109] Graedel (2012): Methodology of Metal Criticality Determination.

Another approach to include the environmental perspective[110] into the criticality matrix is to tackle environmental impacts as another factor within the supply risks. This results e.g. in the following criticality matrix for technology metals (Figure 29).

Figure 29: Combined supply-side and environmental prioritisation of critical raw materials[111]
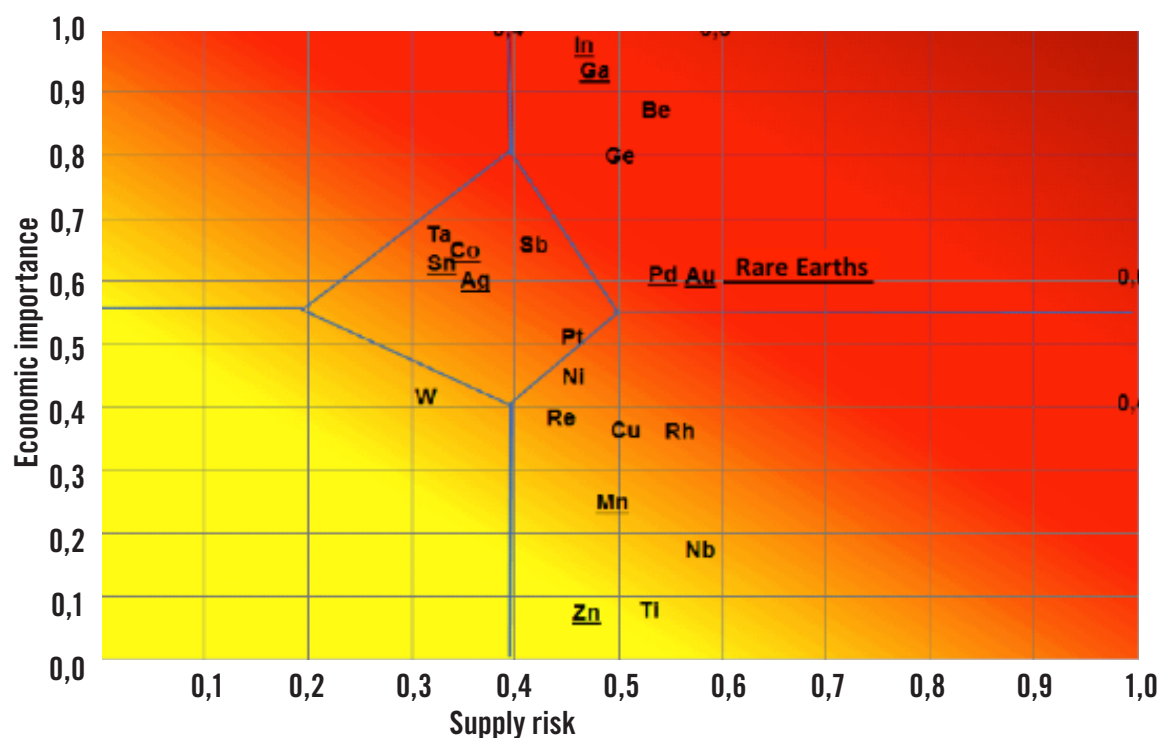
However, according to the relative weight assigned to the different 'risks', the list of critical raw materials may vary. This question arises specifically about how the different natural resource dimensions should be weighted.

The main issue for selecting the relevant materials from a product policy perspective is therefore not one of scientific truth. It is instead a question of (political) consensus that at least certain selected materials, which are of particular importance from an overall societal vantage point, are managed carefully.

The main advantage of a finite list of prioritised materials is that considerations such as 'may not be used in products belonging to a product group of a very limited life time' or 'is to be concentrated in few marked components in order to allow for a high recycling rate' can be made operational in Ecodesign implementing measures and enforced.

Pragmatic Approach C – Dealing with hazardous substances

So far, the standard preparatory study methodology (MEErP) only contains a rudimentary reference to Substances of Very High Concern (SVHC). The wording of this requirement is vague which means that, in practice, when it comes to analysing specific product groups, it is not taken into account in the assessment of Ecodesign options.

From a systematic point of view, emissions of hazardous substances from the production, use and disposal of products have a relevant impact on natural resource use. From a practical point of view, products containing hazardous substances can lead to exposure of humans and the environment as well as hamper re-use, re-manufacturing and recycling.

In contradiction to the expectations of many non-experts, within the chemicals safety assessments to be performed under REACH the use stage of the final product[112] and the end-of-life stage are only considered very roughly and based on quite generic assumptions[113]. Specific exposition risks through certain use patterns as well as the possibilities to avoid risks through changes in the way how the substances are included in the material matrix of a particular product group cannot be identified or dealt with.

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[110] Or better the perspective of the natural resources.
[111] Adapted from Sander et al: Ressourcenschonung und Produktverantwortung (RePro) – Weiterentwicklung der abfallwirtschaftlichen Produktverantwortung unter Ressourcenschutzaspekten am Beispiel von Elektro- und Elektronikgeräten, UFOPLAN Vorhaben (FKZ 3711 95 318), not published.

Furthermore, an evaluation of the environmental risks resulting from the end-of-life of products does usually not take place so far[114]. So REACH does not provide the appropriate basis to address risks from the application of substances in specific articles in a meaningful and efficient way.

Only for the so-called substances of very high concern (SVHC), there is a requirement under REACH to declare the presence of a SVHC contained in a product when it amounts to more than 0.1% of the article's weight. There are ongoing discussions, however, over whether this notification duty refers to the overall amount of SVHC contained in the final article provided to consumers (e.g. a passenger car) or whether it should also refer to its components. The current interpretation of the EU Commission is that it applies only to final products[115]. This can lead to a situation where these very hazardous substances often not allowed to be used in Europe anymore still are placed on the market in significant amounts even without any need to inform the customers. For example, SVHC contained in the sum of imported personal computers may total around 40 tonnes per year for each substance of very high concern[116].

As a result of these limitations of REACH concerning articles, there is a strong need for product policy to complement the safety net regarding a possible exposure against toxic chemicals. One way to address the hazardous substances in products with Ecodesign preparatory studies and implementing measures would be to adapt the staged approach that the Commission and stakeholders developed for the use in the context of the EU Ecolabel.[117]

In short this approach matches distinct groups of substance properties on the one hand with different kind of products or product parts with a differing likelihood of exposure on the other hand[118]. This approach is based on an assessment of the substances classified as being hazardous if used in the respective product group.

Such an approach would create more accurate information about the substances contained in a product, their functions within the products and possible exposure risks. It would also allow an assessment about how to replace them with less harmful substances. The process could establish requirements for implementing measures, either in the form of limits to the amount of substance used or the provision of information.

Any of the three pragmatic approaches above could easily be combined to ensure that:
- Design Options supporting better reparability or durability are identified (through approach A)
- Selected materials are addressed by specific design-for-recycling options (through approach B) and
- Problematic substances are removed from the products as far as possible (through approach C).

HOW TO CUT RESOURCE USE WITH ECODESIGN

BETTER REPAIRABILITY AND DURABILITY of products

+

HIGHER RECYCLABILITY of materials

+

REMOVAL OF HAZARDOUS SUBSTANCES

---

[112] Final products correspond to 'articles' in the REACH terminology.

[113] E.g. the full range of product diversity is differentiated into not more than a handful of different assessment categories.

[114] Even if the REACH text implies that chemical producers have respective responsibilities.

[115] Some member states like e.g. Denmark, Sweden, France and Germany do not support this interpretation and instead see the need to reference the SVHC contend to single articles which are assembled to the final complex product.

[116] According to: REACH Trigger for Information on Substances of Very High Concern (SVHC) – An Assessment of the 0.1% Limit in Articles, Nordic Council of Ministers, Copenhagen 2010.

[117] See http://ec.europa.eu/environment/ecolabel/documents/Chemicals%20HTF_Approach%20paper.pdf.

[118] E.g. substances from a higher hazard class may only be used in a well encapsulated form for the inner parts of a complex article, while for the outer parts only substances with no or low hazard classification may be used.

5.2 How resource efficiency requirements could be integrated within implementing measures

A pragmatic approach using implementing measures of EU product policy should lead to positive outcomes such as

- Reducing the pressure on natural resources in a way other than just reducing energy consumption during the use phase. It would exclude products from the market that waste resources unnecessarily;

- Bringing about substantial benefits to the consumer[119] and to society at large[120];

- The economic and environmental benefits should be measurable and verifiable in a straightforward way;

- The implementing measures should be enforceable by market surveillance authorities without any grey areas.

It seems reasonable to limit early regulatory action to product properties and to directly address production processes only at a later stage.

Product properties refer mainly to the selection of materials for the final product, the design for durability, for reparability and for upgradability, and the design which enhances the recyclability of the product's materials at its end-of-life. All of these properties are closely interrelated because all of them address the issue of increasing material efficiency .

5.2.1 Possible minimum requirements on material efficiency

There are three principles that requirements need to address for the more efficient design of a product within an implementing measure:

- Reduction of specific material input,

- Increasing the intensity of use of the material,

- Increasing the recyclability of the material.

These principles can take the form of different requirements. Some possible examples for requirements are given in Table 7.

For some of these requirements, establishing a list of 'priority materials' is a precondition.

Table 7: Possible mandatory requirements that may be included in binding product regulations in order to decrease environmental impact and supply risks of virgin materials

Possible Requirements	Rationale & Intention	Prerequisite	Verification	Existing Examples
Increasing the intensity of material use				
Minimum share of secondary material in specified parts	If recycled material is used, the initial virgin material (and related natural resources) are used in a more intense way. Requirement gives further push where market forces fail to do.	Assessment whether resource efficient material recycling takes place at a high quality level and sufficient secondary material is or will be available	Feasible (Mainly based on third party certificates, analytical methods only possible for few materials	Minimum recycled share in plastic parts e.g. EPEAT standard for office printers[122] or TCO Standard for Displays[123]
Minimum technical life time and/ or durable product design	By avoiding that a product is discarded because of early failure of on of its components, the (priority) materials in the product can be used for longer/in a more intensive way. This requirement could be implemented either by excluding technical solutions that lead to early failure (e.g. like the use of very simple switches) or by measured/tested lifetime (from laboratory tests).	A product group specific assessment where concrete technical measures help avoid early failure and an assessment about whether respective durability tests are available	Easy regarding excluded technical solutions, more effort (and clear test durability test procedures needed) for lifetime requirements	Minimum technical lifetime requirements e.g. Ecodesign Regulation for Household vacuum cleaner[124] and various lamp types[125]
Design-for-repair and/or upgradability	If the product is designed in a way that it is easy to repair and upgrade it is less likely to be thrown away in case of failure or damage, and more likely to be brought to a repair shop.[126]	A product group specific assessment where design options support or hinder an easy repair	Easy if clear product features are addressed by the requirement	EU Ecolabel criteria for computers.[127] German regulation for electronic products[128]
Reduce the input of priority materials				
Ban the use of priority materials	To avoid the loss of priority materials, these could be banned from certain products if their use is avoidable from a functional perspective	Product group specific assessment showing that the same functionality can be achieved through using other materials.	Easy (if materials are detectable)	None - yet
Limit the (specific) content	The use of priority materials is limited to a defined amount in relation to the function of the product (utility).	Product group specific assessment showing that the same functionality can be achieved with a lower input of the same materials.	Feasible (if material content is detectable and quantifiable)	None-- yet

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122 EPEAT standard for imaging equipment: Any product containing plastic parts whose combined weight exceeds 100 g shall contain at least 5 g of postconsumer recycled plastic.

123 Criteria for TCO Certified Edge Display 2.0: a minimum share of 85% recycled plastic content is required for all bigger plastic parts like housing, backcover, etc.

124 Ecodesign regulation for household vacuum cleaners: The hose shall be durable so that it is still useable after 40,000 oscillations under strain, and the operational motor lifetime shall be greater than or equal to 500 hours.

125 Ecodesign regulations for non-directional and directional lamps: Various lamp types have to meet minimum requirements with regard to lumen maintenance, switching cycles, and a maximum premature failure rate.

126 Such design for repair requirements (e.g. using screws instead of glue, using a modular design) may be complemented by another requirement asking for the availability of spare parts for at least the normal technical use time of the product. Furthermore the availability of detailed and meaningful repair instructions is of high importance for such an approach.

127 European Ecolabel criteria for computers: To facilitate dismantling, fixtures within personal computers shall allow for its disassembly, e.g. screws, snap fixes, especially for parts containing hazardous substances etc.

128 Proposal for the revised version of the German 'Elektroaltgeräte-Gesetz', transferring the EU WEEE Directive – Referentenentwurf, November 2014: Includes the requirement that batteries shall be easy to remove during the use.

Possible Requirements	Rationale & Intention	Prerequisite	Verification	Existing Examples
	Increase the recyclability of (priority) materials included			
Exclude materials that cannot be easily recycled	Some materials can only be recycled through high effort or cannot be recycled at all from a technical perspective. This is true for some technical polymers as well as for some alloys. When such materials are replaced with functionally equal materials that are more easily recyclable, the resource use over the life cycle can be decreased.	An assessment that the use of the easily recyclable materials does not have an adverse impact on the product functions and that recycling of the material is possible under the expected circumstances of disposal (here respective co-regulation regarding waste treatment schemes might be necessary).	Feasible (if materials are detectable, and limitations are clearly described)	EU Ecolabel requirements for displays[129]
Limit or concentrate the use of priority materials to certain components within a product	If priority materials are only included in one or a few of the components of the whole product ,a separate treatment with much higher recycling rates can be achieved more easily (after separation of respective components)	Information about which priority materials are contained in the product	Feasible (if materials are detectable, and limitations are clearly described)	None – yet
Separation of components with a high content of priority materials.	An easy separation of the respective components including priority materials under normal treatment processes makes a separate treatment with high recycling rates feasible and likely	Product group-specific information on the possibilities of modular design and information on the treatment processes	Feasible if separation is defined in a clear and testable way	EU Ecolabel criteria for computers[130]
Exclusion or easy separation, of substances or materials that can have negative effects on a product's recyclability	There are several combinations of substances that cannot be separated by means of the available recycling processes, which do, however, significantly affect the quality of the secondary material and therefore its potential to contribute to resource conservation.[131]	Material and component specific information on the properties of the relevant treatment and recycling processes with regard to their ability (or tendency) to separate (or mix) certain materials.	Feasible (if materials are detectable, and limitations are clearly described)	Substance restrictions under RoHS[132] EPET Standard for imagine equipment[133]

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[129] Proposal by European environmental NGOs to the revision of the criteria document of the European Ecolabel for TVs: The polymere housing of Electronic displays shall not be covered with metal plating surface.

[130] From the European Ecolabel criteria for computers: circuit boards, and/or other precious metal-containing components, shall be easily removable using manual separation methods both from the product as a whole and from specific components (such as drives) that contain such boards to enhance recovery of high value material.

[131] This is true e.g. for copper and iron which cannot be separated after melting.

[132] Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

[133] From the EPEAT standard for imaging equipment: all plastic materials in covers/housing shall have no surface coatings incompatible with recycling or reuse; Plastic parts >100 g shall not contain adhesives, coatings, paints, finishes, or pigments associated with surface coatings that are not compatible with reuse and recycling.

5.2.2 Requirements on the provision of information to consumers and downstream users and recyclers

Establishing mandatory information requirements on resource aspects and minimum design requirements on product properties could have a real impact on resource conservation efforts.[134] Information requirements could be broadly applied by implementing measures under the Ecodesign Directive.

The information could be provided directly with the product (either on the product itself or as part of the technical description) or to provide it separately, through an internet page or from a database.

The information could be provided to the final consumer of the product but also to downstream users like repair shops, re-use facilities or for end-of-life treatment.

The information that is required may have quite different resource-related content such as:

- Information on resource-related product properties,

- Information beyond minimum requirements,

- Information on production chain properties,

- Information on good resource use and disposal processes.

Some examples are listed below.

Information requirements on resource-related product properties

- Declaration of the amounts of (certain) materials contained in the product, including information on the share of secondary material.

- Declaration of the share of (certain) materials in different components.

- Information on technical details concerning the product's use of consumables.

- Information on the technical life time of the product under normal conditions.

Information beyond minimum requirements

- Requirement to provide by how much the critical material use for the product has been reduced below the allowed threshold.

- Information about what substances are not included, besides the Substances of Very High Concern which are already excluded.

Information on production chain properties

- Declaration about the origin of some materials or the applied production processes. Given the nature of the Ecodesign Directive as an instrument that pushes the worst products off the market, it is likely that the information requirements are formulated in the following way *'components of this product are not from …/made with …'.* This would, however, have to be based on political objectives which may differ from country to country.[135]

Information regarding resource friendly use and disposal processes

- Information on the resource-efficient use of a product.
  This can relate to reducing the use of consumables e.g. ink saving printing, and to information about how the service life of a product can be extended e.g. frequent cleaning of print heads.

- Meaningful repair manuals for the product in case of failure in order to prolong the life time of products or, after a first use, information on the possibilities of re-use.

- Information that supports an adequate treatment and recycling of waste products.
  Besides information on the content of hazardous substances or precious materials, this can also include information about how components can be easily separated during a product's end-of-life treatment.

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[134] The criteria developed by the JRC on the resource efficiency with regard to end-of-life actually come down to such information duties, too.
[135] Especially conflict minerals come to mind here; for these it would, however, also be possible to use declarations on manufacturer level.

5.3   Economic aspects of binding requirements regarding resource efficient design of products

From an overall societal perspective, there is little debate about the need for more resource efficient products. These products allow for a more careful handling of priority materials, which reduces their environmental impact and Europe's import dependence with regard to critical materials. They are also a precondition for new business models around repair and maintenance services, leasing and rental options and so called 'reverse engineering solutions'. The first studies conducted on the economic potential of changes in product design and related product services show that numerous benefits are on offer. Apart from the enormous material cost saving potential, a substantial number of jobs can be created in Europe from these new business opportunities.[136]

Reducing Europe's dependence on raw material prices is of vital importance. For some technology-relevant metals and minerals, prices have risen dramatically during the past years and are subject to high price volatility. Reducing the dependence on these materials lowers business risks and therefore is likely to lower business costs. A study for the European Commission has estimated that increasing resource productivity by 2% per year could create two million extra jobs in the EU by 2030.[137]

There are various ways of unlocking this potential. These include financial incentives for the developers of new products, through targeted R&D funds or easily accessible investment capital, market pull instruments such as public procurement rules or meaningful Eco-Labelling criteria, and not least binding minimum requirements that provide a strong regulatory framework for resource efficiency policy.

Only binding minimum requirements can create a level playing field for all market players. This level playing field combined with mid-term benchmarks for future legal requirements under a staged regulatory process are particularly important to make producers take long-term strategic aspects better into consideration when investigating the sustainability of their business models and product portfolio.

A level playing field and a clear mid-term orientation regarding future requirements is even more relevant for small and medium enterprises (SMEs). For them any shift from a 'sell-and-forget' approach to a real 'products stewardship' business model has definitely some risks because of their limited human and financial resources. This is true despite new business models which can offer new and promising economic perspectives.

From a microeconomic perspective, there are technology challenges linked to the design of more resource efficient products. Analyses show that at a first stage, e.g. an increase of the durability of products can be reached by avoiding early failures. Such a reduction of the early failure rate in many cases[138] just means to substitute simple low price parts like switches, handles or cable connectors with others of better performance quality. The sourcing prices of the better parts often only differs by a few cents. But these few cents may still be relevant from the company perspective because of low margins and strong competition in some product sectors. Hence, for the creation of a level playing field, mandatory, clear and easily verifiable requirements on product properties are of high importance for all market actors. These clear rules need to be accomplished by harmonized enforcement efforts across the EU.

If, in a second stage, product policy pushes towards products that are more easily reparable, upgradeable and recyclable, the basic technical concepts and tools for more modular product designs are available. That means respective re-design issues can be handled in a straightforward and efficient way[139]. The efforts for the necessary changes largely depend on the timelines prescribed by the respective regulation. If the necessary re-design can be aligned with the 'normal' product design cycles, additional costs are rather low[140]. Due to this, many industry experts do not expect relevant negative effects under such implementation conditions.

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136 See the Ellen MacArthur Foundation reports 'Towards a circular economy' of 2012, 2013 & 2014.
137 European Commission (2014): 'Study on modelling of the economic and environmental impacts of raw material consumption': http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/RMC.pdf.
138 See e.g. the more detailed case studies by WRAP on increased resource efficiency of products.
139 This is e.g. one of the findings of a three years cooperation project 'IPP-Kompetenznetzwerk Hamburg' financed by the regional authorities in Hamburg, in which product designers, construction and technology experts and product manufacturers participated.
140 See also results from the Greenelec Project: Product Design Linked to Recycling:
141 http://www.hitech-projects.com/euprojects/greenelec/.

So no rational indication is available regarding negative impacts on the final production process. But it needs to be considered that final consumer price and real production costs are not directly interlinked in every product segment. So it can nevertheless happen that some brands will increase their product price with reference to a 'new product quality' or the burden of 'new legal obligations'.

From a consumer perspective, aside from the actual product price, the cost of ownership (like repair/maintenance costs) or cost for other product services (like leasing/rental costs) and the final end-of-use cycle costs are important.

For repair costs, a recent Eurobarometer survey[141] polling EU citizens showed that half of the respondents decided not to have a faulty product repaired over the past 12 months because repair costs were too high. Yet 92% of those polled agreed that the lifespan of products available on the market should be indicated. Products must be durable, easily repairable for little cost, and information on these aspects should be available to consumers.

So possible minimum requirements which would address technical lifespan and reparability could directly satisfy these consumer demands. Electrical and electronic products, as one of the fastest growing sectors, are ideal candidates to increase reparability and longevity.

Unfortunately, no substantial analyses regarding the medium-term economic effects of different resource efficiency scenarios on consumer costs are available yet. A study in Germany on planned obsolescence[142] calculated consumer savings in the range of €60 to 120 billion per year for Germany if products on the market would be without the risk of early failure. The rough assumptions used in this study do however not provide a proper basis for upscaling this to EU level and making sound impacts assessments.

5.4   Results on the feasibility of setting Ecodesign requirements

As the examples in chapters 5.1 and 5.2 show, it is feasible to set various resource-related information and design requirements. With these approaches Ecodesign would be able to remove the worst performing products in terms of resource efficiency from the EU market, without entering the difficult area of an overall resource indicator and the questions surrounding how to identify the very best performing products.

Adopting this pragmatic and staged approach promes real reductions in the use of natural resources. In addition, all available information indicates that such an approach would not interfere with Europe's overall targets for economic development and even supports them by helping to create new business models and market opportunities.

[141] European Commission (2013): Flash Eurobarometer 367 – Attitudes of Europeans Towards Building the Single Market for Green Products. http://ec.europa.eu/public_opinion/flash/fl_367_sum_en.pdf.
[142] See Schridde, S., Kreiß, C. und Winzer, J., (2013): Geplante Obsoleszenz: Entstehungsursachen – Konkrete Beispiele – Schadensfolgen – Handlungsprogramm. Gutachten im Auftrag der Bundestagsfraktion Bündnis 90 / Die Grünen. Berlin.

6. LESSONS LEARNED – GOOD ARGUMENTS TO OVERCOME EXISTING BARRIERS

The analysis presented in this report clearly shows that:

- Products are an important element in any strategy aiming to decouple economic activity and human well-being from the pressure on natural resources (see chapter 2),
- Product design can play a key role in influencing the resource impacts of products (see chapter 3),
- Product policy already has existing instruments, namely the Ecodesign Directive, that can address resource use through rational analysis and balanced decision making (see chapter 4),
- Meaningful and enforceable implementing measures leading to greater resource conservation can be developed and implemented under the existing rules (see chapter 5).

There are stakeholders today who see the need for action but are sceptical about the suitability of the available policy instruments in general and of Ecodesign regulations in particular. In the following section, we answer certain questions about why and how existing barriers to address resource use through EU product policies can be overcome.

Question: How can product policy deliver results on worldwide resource conservation issues?

It is true that particularly for technical products, the pre-production chain processes often have the highest resource impact from a life cycle perspective[143]. But it is also true that product characteristics, including the choice of materials and the way they deliver functional products are defined during the design process[144]. This is the core of product policy.

Minimum requirements for products to be placed on the EU market do trigger an increased resource efficiency within their whole (worldwide) supply chain. Furthermore, it may be expected that these market standards will as well influence the production of products placed on other markets.

Question: How can we make sure mandatory rules concerning product design do not hamper product innovation?

Implementing measures under the Ecodesign Directive are defined in a technology independent way – setting efficiency targets but not prescribing technical solutions. And by removing the most inefficient products from the market it is quite unlikely that innovative products are effected directly.

But more importantly, the level playing field created by the Ecodesign process, combined with the signals set by mid-term targets for a staged revision process leading to an increased level of ambition provide the necessary stability and reliability for product innovation.

Question: Can legally binding rules discriminate against SMEs which then have to introduce new technologies within short timelines?

Most studies on product policy implementation have concluded that on the whole European companies already have the technologies required to meet Ecodesign requirements. Moreover, the legal rules give them an incentive to bring the technology to the market. The level playing field will provide the necessary stability for product innovation and reduce the risks for SMEs.

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[143] See e.g the Notebook example in chapter 3.3.2.
[144] See chapter 3.1.

Question: What can product policy contribute to end-of-life aspects besides existing EU Waste legislation (WEEE, Batteries Directive, Waste Framework Directive (WFD)?

It is true that the WEEE directive and other instruments define clear rules for the treatment of existing waste. But waste regulation and waste treatment or recycling processes have to handle what enters the waste stream.

Ecodesign can help waste prevention and preparation for reuse. Better design solutions support these areas and facilitate high level recycling of parts and materials from products at the end of their use cycle.[145]

It is important that the rules for separate collection and pre-treatment of devices, to unlock the recycling potential of products, are synchronised with product policy.

Question: What parts for optimising the production process are not covered by the Industrial Emissions Directive (IED)?

The IED only covers selected industrial processes. For example, assembly processes during the production of electronic components with quite high resource impacts (as shown by lifecycle analysis) are not covered at all.

The IED and the respective Best Available Technology Reference Documents (BREFs) set targets related to emissions of production processes. But they do not promote a more efficient use of input materials in relation to the output of products[146], which is what resource efficiency would be about.

Most importantly for products placed on the EU market, IED only covers production plants in Europe. Yet there are large amounts of products which are imported into the EU and are not produced in a resource efficient way.

Question: Do resource-related requirements lead to more costly products and less freedom of choice for the consumers?

There is no clear evidence suggesting that this would be the case. Most requirements can be met with existing technical solutions, at relatively little additional cost if at all. And if requirements are implemented in a staged approach aligning re-design activities with the normal product cycle, necessary changes can be easily included in product concepts.

Regarding the product variety, the experiences gained with Ecodesign implementing measures up to now clearly show that some worst performing products are excluded from the market while the (staged) requirements stimulate competition amongst manufacturers to bring new technologies, products and models to the market.

Question: Are resource-related requirements enforceable by market surveillance?

Market surveillance is a crucial aspect of enforcing and creating a real level playing field. For reasons of limited personnel capacity and available resources, market surveillance bodies tend not to support new types of requirements with additional assessment needs. But, as shown in this report, resource aspects can be addressed in a meaningful way as part of a product's properties.

Hence, time-consuming production chain assessments, or respective cross checking of third party verification schemes are avoidable. Existing product testing routines are sufficient in most cases.

The development of more of such agreed test routines – documented e.g. as (harmonised) industry standards for the area of durability and reparability – would support such a pragmatic and effective approach in the best way.

Questions: Do we need to develop and implement new methodology approaches for product group assessments?

The existing standard methodology for assessing products and options to improve them (MEErP) is, in its current form, well prepared to address resource aspects.

The theoretical problem of potentially conflicting effects in different resource dimensions can be avoided if the product improvement is done in a staged way addressing all the 'low hanging fruits' of clearly better design solutions at first.

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[145] Generally, some waste regulation, e.g. the WEEE Directive allow as well to prescribe design-for-recycling options, but this means doubling the product related discussions and leads to the questions how and where overall lifecycle aspects should be considered pragmatically.
[146] Even energy efficiency targets are still a controversial issue with respect to possible binding targets.

The European Environmental Bureau (EEB) is a federation of about 140 environmental citizens' organisations based in most EU Member States, most candidate and potential candidate countries as well as in a few neighbouring countries. These organisations range from local and national, to European and international. The EEB's aim is to protect and improve the environment by influencing EU policy, promoting sustainable development objectives and ensuring that Europe's citizens can play a part in achieving these goals. The EEB stands for environmental justice and participatory democracy. Our office in Brussels was established in 1974 to provide a focal point for our members to influence, monitor and respond to the EU's emerging environmental policy.

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