Preparatory Study to establish the Ecodesign Working Plan 2015-2017 implementing Directive 2009/125/EC

Task 2: Supplementary Report "Identification or resource-relevant product groups and horizontal issues"

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Contents

1. Foreword

This supplementary report has been developed for the project “Preparatory Study to establish the Ecodesign Working Plan 2015-2017 implementing Directive 2009/125/EC”, to aid the decision making in the course of Tasks 2 and 3. Its aim is to identify potentially resource relevant subjects that could be dealt with by means of Ecodesign Regulations, and potential product groups for which these subjects are relevant. This aids in:

- Finding arguments, from a resource perspective, for why certain product groups merit inclusion in a Working Plan;
- Identifying product groups and resource related issues that should be dealt with during the revision of existing Edodesign Implementing Measures; and
- Identifying product groups and issues for which horizontal measures might be appropriate.

In a first step, the report focuses on material efficiency, especially abiotic resources.

It is structured as follows:
In Chapter 2, resource consumption issues related to products are described and possible approaches for tackling these issues by means of design-related product policies are introduced. In Chapters 3, 4 and 5, three different types of requirements are discussed with their potentials, challenges and shortcomings. From this, a set of possible types of Ecodesign requirements that could potentially deal with resource issues is developed in Chapter 0 and linked to typical product groups that present relevant resource issues and may be regulated by means of such requirements. In Chapter 7, conclusions are drawn with respect to potential horizontal measures.

2. Introduction

Resources play an increasingly important role in the European and international debate on sustainable development. While initially being stimulated economically by rising resource prices after 2003 and temporary price peaks such as for rare earth metals in 2010 and 2011, more often environmental and social considerations gain attention. In the 7th Environmental Action Programme (EAP), one of the three identified key objectives is "to turn the Union into a **resource-efficient**, green, and competitive low-carbon economy". In addition growing scientific evidence shows that primary production (mining, processing and smelting) is in many cases associated with severe environmental and social impacts. As an example, the production of 1 g of palladium – which is used in many electronic components - is associated with the emission of more than 9 kg CO_{2e}. Gold has an even higher impact with almost 18 kg CO_{2e} per gram. In addition, the gold mining industry is known as the second largest source of anthropogenic mercury emissions (Pacyna et al. 2006).

Although both examples, palladium and gold, as well as other environmentally relevant raw materials are commonly used in many electronic parts and components of energy-using and energy-related products, the Ecodesign Implementing Measures have so far not specifically addressed these material and resource related issues but focussed mainly on energy consumption in the use phase[1]. Reasons for this are assumed to be the so far:

- Insufficient scientific evidence for the overall relevance of primary production compared to the use phase;
- Insufficient methodological standards and indicators to measure and assess the environmental impacts caused by raw materials extraction and resource/material use;
- Insufficient data on environmental impacts caused by raw materials extraction and resource/material to build upon benchmarks and deviate policy options;
- Difficulty to carry out market surveillance in the absence of certification systems that provide information on the impacts of the resource extraction and manufacturing phase.

The last two aspects will still be challenging when starting to integrate resource and material related issues in the future.

Generally, product related policies can have influence on material issues by the following means:

- Over whole life cycle: Regulating the maximum quantity of materials used per product over life cycle;

[1] Although the Ecodesign Directive explicitly states that "In preparing a draft implementing measure the Commission shall consider the life cycle of the product and all its significant environmental aspects, inter alia, energy efficiency. This includes following life cycle phases of the product: (a) raw material selection and use; (b) manufacturing; (c) packaging, transport, and distribution; (d) installation and maintenance; (e) use; and (f) end-of-life, and following environmental aspects to be assessed where relevant: (a) predicted consumption of materials, of energy and of other resources such as fresh water; (b) anticipated emissions to air, water or soil; (c) anticipated pollution through physical effects such as noise, vibration, radiation, electromagnetic fields; (d) expected generation of waste material; and (e) possibilities for reuse, recycling and recovery of materials and/or of energy

- Over whole life cycle: Regulating the maximum environmental impacts of extraction, production and end-of-life of materials;
- Design/production phase: Regulating the type of materials (e.g. origin: virgin vs. recycled);
- Design/use phase: Regulating the durability of components/products (e.g. quality, upgradeability, reparability and possibilities for re-use, refurbishment and remanufacturing); and
- Design/end-of-life phase: Regulating the recyclability of materials/products.

Generally, the first two of the above listed measures have severe limitations, which can be summarised as follows:

- Benchmarks on the maximum quantity of materials used over the product life cycle represent severe policy interventions in product design, which require sound justifications. Considering the fact that the calculated links between the overall material use and environmental impacts mostly refer to aggregated indicators and generic data, as well as assumptions on product lifetime and end-of-life management, such benchmarks currently appear to be not robust enough for binding Implementing Measures;
- The knowledge on environmental impacts of extraction, production and end-of-life of materials is based on generic LCA (Life Cycle Assessment) data and not representative for each product model. Thus, benchmarks on maximum material-related environmental impacts are currently not feasible (BIO IS 2013a).

Thus, it is proposed to base Ecodesign requirements related to material issues on the last three types of potential provisions, namely:

- Type of materials (e.g. virgin vs. recycled);
- Durability of components/products; and
- Recyclability of materials/products.

The following sections analyse these three types of provisions in more detail and sketch strengths and weaknesses of individual criteria.

3. Type of materials (e.g. origin: virgin vs. recycled)

Requirements on the type of materials could be for example the restriction of materials being known as environmentally harmful (e.g. hazardous substances), or the prescription to use those which supposedly reduce environmental impacts (e.g. renewable or bio-based raw-materials, recycled materials). Restrictions or conditions for the use of hazardous substances are basically covered by other regulations such as REACH (Regulation 1907/2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals) RoHS[2] (Dir 2002/95/EC, on the restriction of the use of certain hazardous substances in electrical and electronic equipment) and CLP (Regulation No 1272/2008 on classification, labelling and packaging of substances and mixtures). Therefore they will not be considered here.

Potential requirements on the type of materials going beyond those regulations can be found in product related criteria documents of voluntary ecolabels such as the European Ecolabel, the Nordic Swan, the Blue Angel, EPEAT or others. Generally, requirements on the type of materials are facing two challenges: on the one hand, the overall environmental benefit of alternative materials is partly controversial[3]; on the other hand, if being regulated as minimum content for a large number of products on the market, the availability of environmentally beneficial materials in sufficient quantity and quality has to be guaranteed. The feasibility and environmental benefit of such criteria therefore will have to be assessed on a case by case basis.

Looking for example at recycled materials, further aspects arise. Existing ecolabel criteria are generally limited to a minimum share of post-consumer plastics and paper, and exclude requirements on metal, for two reasons:

- There is a greater need for setting requirements on plastics and paper recycling in order to stimulate the market than for metals recycling, for the following reason: Metals can be recycled without loss of material quality, with the result that there is often a sufficient economic rationale for using recycled metal, without additional policy measures being necessary. Plastics' recycling, on the other hand, is a difficult field and faces various challenges regarding polymer blends, colour types and flame retardants. For these reasons, post-consumer plastics recycling – and in particular plastic recycling from electrical and electronic equipment – often is not economically viable for recyclers without additional policy interventions, so that the supply of high-quality post-consumer recycled plastics is insufficient so far[4]. Minimum requirements for the content of recycled plastics (on a voluntary basis by ecolabels or obligatory by regulation),

[2] With regard to electrical and electronic products, the implementation of the RoHS-Directive led to a quite comprehensive ban of lead, mercury, cadmium, hexavalent chromium, polybrominated bipenyls (PBB) and polybrominated diphenyl ether (PBDE) in all devices put onto the EU market.

[3] Manufacturers argue for example that a fixed minimum percentage of recycled content might result in a lower performance of materials which might cause failures, damages or shorter lifetime of products and thus resulting in an overall increased consumption of materials.

[4] Another major reason for this situation is overcapacities in waste incineration. These overcapacities represent a major competing alternative for plastics recycling.

can generate an additional stimulus for plastics recycling. Paper recycling is also associated with losses of quality and therefore subject to so-called ”downcycling”, however considered to be less critical from a technical and economic perspective;

- Further, while recycled plastics is clearly following separate management streams until used in production, this is not always the case for metals. Recycled metals are often melted in the same facilities as primary material, making it difficult to impossible to give exact quantitative figures for the recycled content.

Therefore, requirements on recycled content, if any, would rather make sense for plastics and paper than metals.

Regarding the origin of primary materials, Ecodesign requirements could in principle take the form of information requirements disclosing the origin to the consumer. However, the lack of source documentation and certification has so far prevented such product related requirements. Nevertheless, in the last years a variety of initiatives emerged aiming to certify the origin of minerals, metals, or wood-based products. While a key focus of these origin certification are the so called conflict minerals (typically defined as tin, tantalum, tungsten and gold), some other metals are addressed by related initiatives (e.g. the aluminium stewardship initiative). It is noteworthy that the European Commission published a draft Regulation on minerals from conflict-affected and high-risk areas[5]. In a related joint communication document, it is stressed that this measure should be flanked by public procurement initiatives (European Commission 2014). Depending on the exact implementation, this could lead to a situation in which also producers of products have to make sure that their direct and indirect sourcing of tin, tantalum, tungsten und gold is in line with international standards such as the OECD Due Diligence Framework (see OECD 2011). As this policy process is still in progress, it seems advisable to await its results before considering Ecodesign (information) requirements.

[5] Proposal for a Regulation of the European Parliament and of the Council setting up a Union system for supply chain due diligence self-certification of responsible importers of tin, tantalum and tungsten, their ores, and gold originating in conflict-affected and high-risk areas. European Commission, Brussels, 05.03.2014.

4. Durability of components/products

Requirements on durability affecting resources and materials of products can be of different types.[6] Design-related requirements are, according to (BIO IS 2013b):

- Durable product design which increases the technical lifetime; and
- Upgradability (e.g. with software updates).

Furthermore, product related criteria documents of voluntary ecolabels such as the European Ecolabel, the Nordic Swan, the Blue Angel, EPEAT or others also propose the following design-related measures to facilitate a prolonged lifetime of products:

- Design for reparability (components to be easily accessible and exchangeable); and
- Information requirements regarding clear and publicly available disassembly and repair instructions to enable a non-destructive disassembly of products and replacement of key components.[7]

The effectiveness with regard to a real extension of product's lifetime and improving environmental impacts is largely unknown. This is due to the following reasons:

- There is very limited knowledge on real user behaviour in the various EU Member States. Thus, data on lifetimes as well as on the impacts of reparability and durability criteria typically rely on estimates;
- The actual lifetime is often not identical with the technical lifetime. In particular for lifestyle products, the actual lifetime is often well below the technical life time (BIO IS 2013b). For example, for televisions the most critical driver of TV replacement is a desire to trade up in size, followed by wanting to own a flat panel TV with improved picture quality. The existing TV being outdated or broken is a strong driver for TV replacement, but not one of the top reasons (Graulich et al. 2013). In such cases, requirements related to reparability and durability may have limited influence on the actual product lifetime. As a response, some studies suggest to have stronger focus on criteria promoting second-hand use of lifestyle products. This could for example encompass requirements on easy, reliable and secure mechanisms to erase or retrievably archive personal data from information and communication devices. (Manhart et al. 2012);
- For many product groups, durability criteria are difficult to establish. While there are independent test methods related to durability of some few product groups (e.g. lamps), most other product groups lack such independent standards, which could form a starting point for product related requirements. This also affects missing quality/durability standards for important components influencing the overall lifetime of the product in case of defect, such as the hard

[6] Furthermore, there a non-design related instruments with their specific advantages and difficulties which will however not be in the focus here. Among them are: Availability of spare parts; long support time or lowering the costs for repair compared to the purchase of a new product (BIO IS 2013b)¸ or requirements for an additional manufacturers' warranty or service agreement period beyond the legal guarantee (various ecolabels).

[7] Furthermore, there are requirements for an additional manufacturers' warranty or service agreement period beyond the legal guarantee, an instrument that is not relevant in the Ecodesign context, however.

disc drive of computers or rechargeable batteries of ICT and other products.[8] However, it is of course possible for the Commission to issue standardization mandates in the course of the Ecodesign process. Standardization and the development of requirements have often gone hand in hand in the past;

- Design for durability, reparability or recyclability (see next section) might interfere with each other, for example in cases where adhered components or composite materials might increase the durability but hamper reparability and recyclability. However, from a general policy perspective, it should be considered that waste prevention and reuse clearly ranks above recycling within the European waste hierarchy laid out in the EU Waste Framework Directive (2008/98/EC).

Generally, it has to be kept in mind that long product lifetimes also might cause adverse environmental net-impacts. This might be the case for product groups that cause their largest environmental impacts during the use phase and that face significant future improvements in use-phase efficiency (e.g. cooling and freezing equipment). Nevertheless, it was demonstrated that the extension of the use-phase holds significant improvement potential for products such as notebooks (Prakash et al. 2012). Therefore, decisions for or against Ecodesign requirements on durability, need to be based on sound assessment using a total product life-cycle approach.

[8] Within the framework of developing new criteria for The European Ecolabel, a durability testing for notebook computers was proposed. The proposed test is not based on an existing European Standard, but tries to bridge the practical problems resulting from a lack of standards by widely referring to a US-American standard (Development of European Ecolabel and Green Public Procurement Criteria for Personal & Notebook Computers – Technical Report, Criteria Proposal, Revision v2).

5. Recyclability of materials/products

Ardente et al. (2011a) stress that there are various legal documents and definitions making differences between recyclability and recoverability. In general, the term "recycling" means any recovery operation by which waste materials are reprocessed into products materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations." (Directive 2008/96/EC Article 3.17). In contrast, "'recovery" means any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy." (Directive 2008/96/EC Article 3.15). This includes, for example, the incineration of waste in order to generate energy.

As the European waste hierarchy clearly gives recycling a higher priority than recovery operations, product policies typically aim to promote recycling and recyclability over (energy) recovery and recoverability. Recyclability of materials and products can be addressed by various types of requirements:

- Requirements aimed at improving the dismantleability of devices (e.g. use of clip-connections);
- Requirements aimed at improving the recyclability of components (e.g. ban of coated plastic parts); or
- Information on product specific dismantling/recycling practices and material content (e.g. publication of dismantling guides, information on contained materials).

In particular, the first and second aspect are currently intensively discussed in the Ecodesign process. With respect to the second aspect, Ardente et al. (2011b), amongst others, presented various indices to gauge product specific reuseability, recyclability and recoverability. With these methods, each component and material of a product receives a certain value representing the degree in which it could theoretically be reused, recycled or recovered (in terms of energy recovery). From these data, the total product specific weight percentage of potential reuse, recycling and recovery is calculated. For application in Ecodesign, the authors suggest to use such indices (e.g. RRR Benefit Ratio) for Ecodesign requirements, which should then be verified by producer self-declaration, including adequate technical documentation. While this strategy can be a useful path towards integrating resource aspects in Ecodesign, its implementation still requires more case studies and standards related to input data and documentation. This is particular important as market surveillance also depends on sound and uniform assessment and documentation. Furthermore, the index only covers the theoretical reusability, recyclability and recoverability without taking into account actual recycling capacities. It is therefore not guaranteed that requirements based on such an index actually lead to improved recycling or reuse.

With respect to the first aspect, it is discussed to base requirements on the maximum time required to dismantle a product and to separate the most relevant parts for recycling (e.g. printed circuit boards, batteries, display-units). This approach is currently discussed in relation to the revision of Ecodesign Regulation 642/2009 for television sets and monitors and is widely based on assessments and recommendations by Ardente & Mathieux (2012). The advantage of such an approach is the consideration that the dismantling time is a crucial factor for recyclers to decide for or against a careful and resource-conserving extraction of relevant fractions. This requirement is not covered by the requirement of the Batteries Directive (2013/56/EU) for removability during the use phase: while the dismantling time is particularly critical for recycling operations, repair operations during use phase are somehow less dependent on very rapid dismantling options. For example, if a battery can be removed by opening various screws, the device would fulfil the requirement of easy battery exchange in the use phase but not of quick dismantling for recyclers. Another major difference between dismantling for recycling and dismantling for repair is the fact that repair operations have to avoid any damages to parts and components, while dismantling for recycling can tolerate a certain level of destructive processes.

In any case, such requirements have to be based on independent test standards, which are not yet available. However, as mentioned before, the development of Ecodesign requirements can be accompanied by standardization work.

Regarding the provision of product specific information, some authors suggest that full material declaration of products can help recyclers to optimise their processes. Nevertheless, it has to be considered that recyclers mostly receive batches of mixed end-of-life devices, which makes it practically difficult to use model specific information on material composition. In certain cases, easy-to-read related information displayed on devices might in fact help to facilitate recycling decision. One example is the marking of electric motors and generators regarding the use of permanent magnets[9] (Buchert et al. 2014). Another proposal addresses the declaration of the indium content of displays (Ardente & Mathieux 2012).

Regarding requirements aimed at improving the recyclability of components, ecolabelling criteria introduced various requirements limiting the number of polymers used in one device and/or banning the coating of plastics. Also, requirements limiting the use of certain additives, e.g. black dye in plastics, are conceivable. While these criteria aim at improving the recycling of plastics, industry representatives stress that prescriptive requirements on the use of polymers and composites might have negative impacts on innovations that could lead to other resource-.efficiency gains in the future.

[9] While many electric motors are not equipped with permanent magnets, an increasing number of energy efficient motors use magnets containing rare earths. While these magnets could become quite attractive for recyclers, it is quite difficult to identify devices with magnets without any product-specific information. Thus, a marking of motors regarding their magnet use and magnet type could help to tap future rare earth recycling potentials.

6. Conclusion I: Potential conditional Ecodesign requirements

Based on the analysis in the sections above, Table 1 presents generic resource requirements that can be considered for the use in Ecodesign Implementing Measures, The table should be understood as a check-list serving as a basis for product-specific assessments such as Preparatory Studies. A more detailed assessment should be carried out on a case-to-case basis.

Such a checklist could be included in the Methodology for Ecodesign of Energy-related Products (MEErP) to ensure that such an assessment is carried out systematically for any product group.

In addition, it is recommended to develop independent test standards on issues affecting recyclability and durability. Such standards are in many cases prerequisites for effective Ecodesign requirements and the standard development is seen as an important step towards improved material-efficiency of products.

Table 1: Checklist for potential resource related Ecodesign requirements

Product group	Requirement	Rationale	**Comments**
All devices containing significant amounts of plastics and/or cardboard/paper	Material type: Minimum content of post-consumer recycled plastics and/or cardboard/paper	In order to strengthen the market for post-consumer recycled plastics, minimum requirements on the content of recycled plastics can be applied.	The market supply of (high-quality) recycled materials has to be secured. Verification methods to identify the recycled content have to be established.
Products with highest environmental impacts in production and low use-phase efficiency improvement potential (e.g. notebooks, tablet PCs, mobile phones, digital cameras)	Durability: Minimum requirements related to quality, durability and reparability of products and/or relevant components	For these products, an extension of the use phase holds significant environmental improvement potential (to be verified by product specific LCA studies)	In many cases, test standards for measuring quality and durability of products or components still have to be developed.
	Durability: Information requirements regarding clear and publicly available disassembly and repair instructions	To facilitate repair and reuse.	
Products with data storage capacity (e.g. computers, mobile phones)	Durability: Reliable means to archive or irretrievably remove personal data	The existence of personal data on storage devices and the common difficulties to	

Product group	Requirement	Rationale	Comments
		safely erase such data is considered to be one obstacle for reuse.	
Electric motors, generators and devices containing electric motors and products containing permanent magnets (e.g. fans, pumps, elevators, machines)	Recyclability: Marking related to permanent magnets: Does the device contain permanent magnets? If yes, which type (e.g. SmCo, FeNdB)	Electric motors and generators are increasingly equipped with permanent magnets (with rare earth elements) to increase energy efficiency. Recyclers have to be able to easily separate motors with permanent magnets from other motors to facilitate specific recycling.	Also see recommendations in section 7.1
All devices containing significant amounts of plastics	Recyclability: Marking of plastics	Marking can facilitate the sorting of plastics and thus facilitate recycling. Although plastics are often sorted using automated sorting processes which are not related to marking, there are still recyclers that do take the marks into account. It is believed that these enterprises would benefit from a systematic strategy to use plastic marking in EU product policy.	No comprehensive and up-to-date knowledge on the benefits of plastics marking.
	Recyclability: Use of homogenous and recyclable (plastic) materials; avoidance of certain additives	The use of homogenous and recyclable plastics is thought to have positive impacts on end-of-life recyclability.	The positive impact has to be evaluated carefully, as such measures might not only improve recyclability of materials, but could also limit innovative solutions requiring less input material.
Battery powered electronic devices (e.g. notebooks, tablet PCs, mobile phones, digital cameras)	Recyclability: Easy extraction of rechargeable batteries	The battery contains critical metals such as cobalt. These metals can be recycled but require a separate treatment in special refineries. Easy and rapid extraction in end-of-life management can help to make battery recycling economical	Also see recommendations in section 7.2

Product group	Requirement	Rationale	**Comments**
		viable.	
Products containing specific materials that require separate treatment in the recycling process and where the presence/absence of these materials cannot be recognised from the outside.	Recyclability: Information on material content for recyclers	To support the extraction and separate treatment in the recycling process.	E.g. requirements to mark products containing hazardous substances and/or defined minimum amounts of critical metals.
Products with parts and components containing specific materials that require separate treatment (e.g. TVs, displays, computers, servers, set-top boxes, routers)	Recyclability: Easy extraction of printed circuit boards and other resource relevant components (e.g. permanent magnets, display units)	Printed circuit boards from electronic devices need to be fed into specialised recycling processes to recycle metals of high environmental and economic importance (e.g. gold, PGMs). Non-destructive (manual) extraction can significantly improve the recycling rates of some of the contained metals.	Requirements on e.g. fixtures of components within a device might have only limited influence on practiced recycling technologies
	Recyclability: Maximum dismantling time	A maximum dismantling time can ensure that resource conserving and non-destructive recycling approaches can be carried out economically	No test standards on measuring dismantling time available yet.
All products	Threshold value related to the Reusability, Recyclability and Recoverability potentials (RRR-indices)	RRR threshold values might stimulate product design using parts and materials that can theoretically be reused, recycled or recovered at the end-of-life.	Net environmental benefits need to be assessed by life-cycle assessment studies on a case-to-case basis. Little experiences available with the application of RRR-indices and its impacts.

7. Conclusion II: Potential horizontal measures

Regarding potential horizontal measures, it is concluded that only few approaches related to material efficiency are mature enough to be addressed in the short-term by elaborating horizontal measures. Nevertheless, the analysis also shows that there are two particular cases, where horizontal measures are likely to yield significant improvement potentials while being comparably well understood in terms of potential effects. These two potential horizontal measures are presented in more detail in the following sections. It is recommended to conduct further investigations (e.g. a preparatory study) to elaborate these approaches and to study and quantify potential costs and benefits.

In addition, it is recommended to collect more scientific information on potential Ecodesign requirements on plastics, including the use of recycled plastics, marking of plastic parts and the use of polymers and composite materials. It is believed that such a study could significantly help to clarify the question whether horizontal measures can yield net environmental benefits.

For all processes it is recommended to take into account potential side-effects affecting product durability and life-time. As demonstrated by Prakash et al. (2012), the total product life-time has a very high influence on the total environmental performance of many IT-products such as notebooks. Thus, potential gains in terms of increased recycling should be carefully balanced against potential rebound effects.

7.1 Marking of devices containing components with specific materials

As illustrated in section 5, product specific information on the content of materials can help recyclers to optimize their processes and to recycle critical raw materials. An illustrative example is products containing medium and large size rare earth magnets (e.g. pumps, generators, electric motors): as rare earth magnets are only used in a certain market segments (mostly energy-efficient devices), recyclers cannot base decisions related to a potential magnet recycling on the type of product. In particular with electric motors, it was shown that devices with rare earth magnets are quite hard to identify as such without having very specific technical know-how or without conducting quite intensive testing/dismantling of devices (Buchert et al. 2014).

Thus, a mandatory and standardised marking of products containing rare earth magnets above a certain minimum weight (e.g. > 10 g) can significantly facilitate future recycling practices. It is believed that a marking giving information on the presence of rare earth magnets as well as information on the applied type (e.g. SmCo, FeNdB) can positively influence the establishment of a European circular economy for rare earth elements.

It is therefore proposed to elaborate a horizontal implementing measure on the marking of products containing components with specific materials such as rare earth elements or tungsten. Apart from rare earth magnets, this could also comprise other products and components that commonly contain materials being critical in terms of security of supply as well as their environmental and social impacts in the production stage. Thereby, highest priority should be given to products and components that contain high amounts and/or high concentrations of critical metals that require separate treatment for recycling. Of course, such measures should take into account existing and developing recycling infrastructure and processes.

7.2 Design-for-recycling: End-of-life removability of rechargeable batteries

Devices powered by rechargeable batteries such as Li-Ion or NiMH could be addressed by a horizontal implementing measure ensuring that the batteries can be extracted at the end of life at high rates and within the economic limits of recycling enterprises. The rational for this is the fact that rechargeable batteries contain significant amounts of critical materials such as rare earth elements and cobalt. For the recycling of these materials, Li-Ion and NiMH batteries need to be separated from the devices to be recycled in specialised facilities. With regards to cobalt, rechargeable batteries represent 27% of the world consumption, which makes batteries the most important technological application the element is needed for (Zepf et al. 2014). Around 51% of the world's primary cobalt supply is mined in the Democratic Republic of the Congo, mostly under sub-standard conditions in terms of health-and-safety, child labour as well as environmental impacts (Tsurukawa et al. 2011).

Although there is an existing recycling infrastructure for cobalt from rechargeable batteries in the EU (e.g. represented by Umicore Battery Recycling or Accurec), the majority of end-of-life NiMH and Li-Ion batteries do currently not enter systems where rare earths and cobalt can be recycled. Apart from issues such as unsound disposal (e.g. via municipal waste-stream) and export of used equipment to non-EU-countries, this also has to do with the difficulties of recycling enterprises to extract the batteries from end-of-life equipment. Although Annex VII of the European WEEE-Directive (2012/19/EU) lists batteries as an e-waste fraction that requires selective treatment, the normative Annex A of EN Standard 50625-1 on Collection, logistics & treatment requirements for WEEE – Part1: General treatment requirements (Final Draft as of September 2013) specifies this requirement in a way that only "batteries which are accessible in the equipment without using tools shall be removed from WEEE before any treatment process that can cause damage to them. Batteries which are not accessible in the equipment without using tools shall be (part of) an identifiable stream […]". Therefore, batteries that cannot be removed without tools do not have to be fully and systematically separated from the e-waste stream.

The background for this regulatory set-up is the fact that many battery-containing devices are designed in a way, which makes it difficult and time-consuming to extract rechargeable batteries prior to (mechanical) treatment. A study conducted by Schischke et al. (2013) revealed that the batteries of many tablet computers are mostly glued into the device or fixed in a way that removal requires the opening of (up to 12) screws. Thus, extraction of all rechargeable batteries would cause labour costs that cannot be compensated for by the gains from improved material recycling. For this reason, recyclers often do not extract all rechargeable batteries from the end-of-life devices. Subsequently materials such as rare earths and cobalt are lost in downstream recycling processes.

Product design can therefore significantly help to bridge these structural problems and it is recommended to conduct a preparatory study on a horizontal measure on this issue[10]. Although issues on design-for-recycling are covered by Article 4 of the WEEE-Directive, this segment of the Directive does not contain any requirements influencing the removability of batteries from electrical

[10] While it is recommended to focus on the end-of-life removability of rechargeable batteries, such a preparatory study should also elaborate on potential criteria, costs and effects for the removability of other fractions such as printed circuit boards and liquid crystal displays.

and electronic equipment. In turn, this segment makes reference to the Ecodesign Directive (2009/125/EC) for potential requirements facilitating re-use and treatment of WEEE.

Potential requirements on end-of-life removability are not necessarily identical with criteria on use-phase-removability as specified in Article 11 of the Battery Directive (2013/56/EU). This is because battery exchange during the product use-phase has to be done without damage to the equipment. In contrast, end-of-life removal can accept a certain level of damage. Furthermore extraction at the end-of-life is significantly more time-sensitive so that – in the case of rechargeable batteries – design-for-recycling is not yet covered in the existing regulatory framework.

8. References

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