Resource Efficiency and Depollution – Conducting a stakeholder process to derive enhanced treatment requirements for WEEE

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Keywords: WEEE, recycling, depollution, resource efficiency, secondary materials

INTRODUCTION

Production, use and waste generation of electrical and electronic equipment (EEE, WEEE) worldwide have been growing rapidly in recent years (Forti et al., 2020). This is associated with impacts on health and environment, resource depletion and ethical concerns. Recycling of materials contained in WEEE considerably contributes to reduce adverse environmental impacts. Since WEEE contains numerous valuable materials but also various hazardous substances (Crowe et al., 2003) proper depollution and resource efficient recycling have to be carried out. Standards (e.g. for suitable techniques, limit values and monitoring requirements) help to implement Circular Economy (Flynn and Hacking, 2019). The German Environment Agency (UBA) developed a set of state-of-the-art WEEE treatment requirements and proposed to implement them in national legislation (UBA, 2020).

MATERIALS AND METHODS

The research design followed a multi-step approach: Best available techniques, current treatment methods, waste quantities, environmental motivation and economic aspects were identified through a survey among treatment plant operators and a literature review including an analysis of EN 50625 standards. Vetted treatment requirements focussing on both depollution and resource efficiency were derived in an iterative process involving over 200 stakeholders, i.e. treatment plant operators, producers of EEE, NGOs, and representatives of authorities. Derived requirements aim at processes, output targets, treatment concepts, and proper monitoring.

RESULTS AND DISCUSSION

UBA developed 57 recommendations for treatment requirements for WEEE. These include the adaptation of selected depollution targets and limit values from the EN 50625 standards but also go beyond. Requirements also concern pre-shredder separation obligations for certain components such as accessible batteries and valuable printed circuit boards. Further, the separation of neodymium containing magnets from hard disk drives and pedelecs was recommended. In the following, the examples of photovoltaic modules (PV) and plastics recycling will be outlined.

Recycling of photovoltaic modules

Global PV waste is projected to amount to 60 to 78 Mt annually in 2050 (Weckend et al., 2016), surpassing the total amount of WEEE arising in 2018 (Forti et al., 2020) (see Table 1). So far, no legislative requirements for PV treatment and recycling are in place, neither on European nor on national level.

Table 1 Current WEEE and projected PV waste

	WEEE 2018	PV 2030	PV 2050
Global	51.8 Mt	1.7 to 8.0 Mt	60 to 78 Mt
Germany	0.9 Mt	0.4 to 1.0 Mt	4.3 Mt

The concept developed for PV treatment consists of the following main treatment requirements: (1) Separate treatment of silicon-based PV modules from those based on other semiconductors, (2) Steering of glass and aluminum fractions into high-quality recycling processes, and (3) Limit values for hazardous substances in materials for recycling (see table 2). Mixed treatment is only permitted, provided the respective lower thresholds are met. Glass and aluminium recycling contributes most to the greenhouse potential of PV production. Thresholds are derived from EN 50625 standards, though partly tightened to reflect best available techniques.

Table 2 Limit values for glass and other materials for recycling from PV waste

	Pb	Cd	Se
Si-based	100 mg/kg	1 mg/kg	1 mg/kg
Non-Si	10 mg/kg	1 mg/kg	10 mg/kg
mixed	10 mg/kg	1 mg/kg	1 mg/kg

WEEE Plastics recycling targets

Roughly 20% of total WEEE mass is made up of plastics (Delgado et al., 2007). Despite a potential of roughly 50% of plastics contained and considerable ecological benefits (Wäger and Hischier, 2015), only one fifth of plastics from WEEE is recycled in Germany. Recycling efforts are limited due to the cumbersome depollution necessary and low prices for primary materials.

Table 3 Recommended plastic recycling targets (percent of total WEEE mass) by category

Category (Annex IV of WEEE Directive)	Avg. plastics content	Recycling target
1 Temperature ex-change equipment	15-20 %	10 %
2 Screens (only LCD)	25-35 %	10 %
4 Large equipment	20 %	10 %
5 and 6 Small equip-ment (IT and telecom.)	25-45 %	10 %

Material specific recycling targets shown in Table 3 were derived for plastic-rich WEEE categories, based on average plastics content from literature. These take into account the specific hazardous substances content such as brominated flame retardants.

CONCLUSION

The recommended WEEE treatment requirements could considerably enhance depollution and resource efficiency. However, during the legislative process a number of proposals were not adopted, including requirements aiming at material recovery, e.g., of precious and minor metals and plastics, which currently lack economic feasibility.

The process to derive recommendations was quite elaborate but the integration of the various stakeholders was necessary to get insights on treatment processes and the feasibility of further requirements. Due to the dynamic development of EEE material composition and WEEE treatment techniques regular revision of the proposed requirements is recommended.

ACKNOWLEDGEMENT

For this research two projects where commissioned - conducted by Dr. Brüning Engineering and Ökopol. Further we would like to thank all stakeholders who have enriched the process with their expert knowledge.

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