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WEEE in Serbia: Status of pre-treatment methods and its influence on the recovery of critical metals

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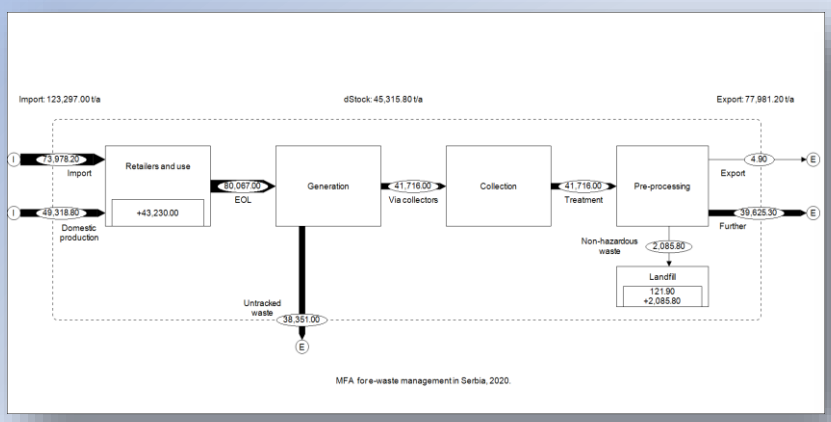
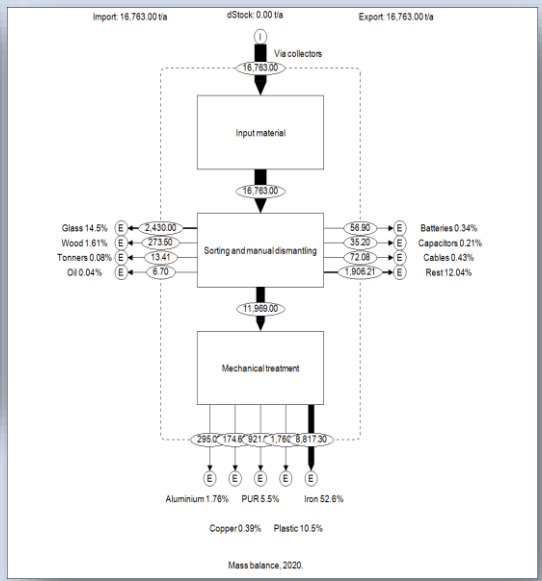
Waste electrical and electronic equipment (WEEE) represent one of the fastest growing waste streams in the world, with an annual growth rate of 3% to 5%. In addition to containing potentially hazardous substances, it also contains valuable secondary raw materials which can be recovered by adequate recycling and recovery treatment. Pre-treatment is a key step in e-waste management to ensure the efficiency of subsequent processes and the quality of output materials. Currently, conventional recycling methods are largely based on recovering ferrous and non-ferrous metals, plastic and glass, but majority of critical metals and rare earth elements are lost during the pre-treatment processes. In this paper, on the example of Serbia, and using the material flow analysis (MFA), the current status of WEEE and pre-treatment methods are presented. Further, an overview of the presence of certain critical metals (CM) in most relevant categories of electronic equipment is given and general recommendation for avoiding CMs losses within the WEEE treatment chain are discussed.





WEEE management system in Serbia consist of collection of this waste stream and its pre-treatment, while the final treatment technologies are not represented. There are four main operators in Serbia that carry out organised collection and recycling of electronic waste. In business sector around 500 companies participates in collection of e-waste through formal sector, collecting mainly IT and telecommunication equipment. Beside this, there is significant informal network in Serbia for collection of e-waste. Those data are not represented in official statistics, but it is estimated that there are between 5,000 and 8,000 informal collectors of e-waste.

To meet certain specifications in individual EEE products several typical critical metals are widely consumed in electronics: lithium and cobalt (rechargeable batteries) indium (LCD glasses, semiconductors/LED), REEs (permanent magnet, battery alloy), gold (PCBs, bonding wire, contacts), silver (switches, lead-free solders, conductors), platinum (hard disk, resistors, plasma display panels) etc. Beside the huge demand of critical metals, their deficiency in the Earth's crust and existence in a few regions present serious depletion and supply risk. Thus, to address this problem, the most reasonable method is to increase the recycling efficiency of secondary resources

Once e-waste is collected, dismantling, pre-processing and end processing are inevitable stages for safe disposal or recycling. To ensure that liberated materials enter the appropriate recovery process pre-treatment phase is crucial. In general, it includes manual dismantling, mechanical processes and combinations of manual and mechanical pre-processing. Manually extracted components (batteries, cables, cathode ray tubes etc.) are sent further to secondary treatment plants for further processing. Mechanical treatment consists of shredding, milling, magnetic and other types of separation, whereas refrigerator treatment plants usually have a line for Freon separation. Pre-treatment technologies that are currently in use are customized for efficient separation and recovery of "mass relevant" fraction in e-waste, mostly metals (Fe, steel, Ni, Al, Cu) and non-metallic fraction like plastic, rubber, glass and textile, while the majority of CMs are lost as they stay coupled with dominant metal output fractions, or end up in the dust from the process.

***Recommendations**

-more reliable and transparent information about the content of critical metals in the different equipment groups and their component is needed

-further studies and surveys on recycling behaviour of consumers

-optimized structure and design of electronic products would contribute to easier manual disassembly and recycling processes

-when it comes to pre-treatment, it is essential to focus activities on improvement of manual disassembly and separation of target components in e-waste that contain high concentrations of critical metals

-focus on future studies should be on developing technologies for automatic recognition, sorting, and dismantling of WEEE