Resources, Conservation & Recycling xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec

Full length article

Perspectives on reuse of WEEE in China: Lessons from the EU

Bin Lu[a], Jianxin Yang[a,*], Winifred Ijomah[b], Wenjie Wu[a,c], Gabriel Zlamparet[d]

[a] State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences,Shuangqing Road 18, Haidian District, Beijing 100085, China
[b] Design Manufacture and Engineering Management, University of Strathclyde, Glasgow, UK
[c] Shanghai Collaborative Innovation Centre for WEEE Recycling, Shanghai Second Polytechnic University, Jinhai Road 2360, Pudong District, Shanghai 201209, China
[d] State Key Joint Laboratory of Environment Simulation and Pollution Control, School of Environment, Tsinghua University, Beijing 100084, China

ARTICLE INFO

Keywords:
Reuse
Waste electrical and electronic equipment
Sustainable management
Stakeholder analysis

ABSTRACT

Reuse is always considered superior to materials and energy recovery in the waste hierarchy, a concept that also applies to Waste Electrical and Electronic Equipment (WEEE). In practice, however, reuse has not been a commonly used end-of-life option. We compared policies and practices of reuse of WEEE in China and in the EU. This comparison can help identify knowledge gaps and reuse policy requirements, as well as implementation methods We also discuss potential scientific solutions for reuse of WEEE via analysis of stakeholders' concerns. We found that although there are already reuse-related guidelines and standards in China, the policies need to be made more systematic like those of the EU, and they need to be more suitable for the specific challenges of China. We propose$ policy recommendations for reuse in order to facilitate sustainable management of WEEE, including integration of a reuse strategy into current management policy as well as the promotion of components reuse. Further, we also found that more studies on drivers and barriers to reuse are required to support more effective and efficient management.

1. Introduction

Waste Electrical and Electronic Equipment (WEEE) is increasing rapidly globally (Zeng et al., 2016) and has become one of the most important types of solid waste. The proper treatment and disposal of WEEE are indispensable for the development of a circular economy. Since improper treatment of WEEE may cause severe pollution, environmentally friendly recycling has been heavily promoted by laws and regulations in recent years. In developed countries, Extended Producer Responsibility (EPR) based laws or directives have been enacted, such as the WEEE directive in the EU, which is an important part of the circular economy policy package (EU, 2017). Besides materials recycling, reuse is also an important strategy in 3R (Reduce, Reuse, Recovery) principles for solid waste management, including for WEEE (Devoldere et al., 2009; Truttmann and Rechberger, 2006; Williams et al., 2008). In the waste hierarchy, reuse is preferred over materials recovery, energy recovery, and disposal (EU, 2008). Reuse can alleviate or moderate the potential environmental pollution from WEEE, although it is not a final solution to the problems WEEE causes (Ruediger et al., 2011).

In theory, reuse of WEEE is more complicated than materials recovery, because reuse is not only affected by the physical condition of the products and components themselves, but also by technological innovation of newer products with similar functions. The factors that influence reusability individually or in combination can be categorized as technological, economic, environmental, social and cultural, and legal (Borrman et al., 2009).

Measures to promote reuse exist in most countries' waste management laws or regulations. However, the implementation means are different between countries. In China, reuse is not even included in the major regulations of WEEE management, though reuse is common in the recycling process. In the EU WEEE Directive, the reuse rate has been listed as part of the WEEE recycling target for member states. Therefore, it is necessary to analyze and compare different WEEE management policies and legislative systems in different areas, as the lessons may be helpful globally.

Because most WEEE in developed countries is recycled, previous studies on WEEE have mostly focused on recycling efficiency (Parajuly and Wenzel, 2017). In the literature concerned with reuse, assessments of reuse potential of different WEEE categories (Bovea et al., 2016; Lu et al., 2014; Parajuly and Wenzel, 2017) has found management policy and implementation to be the key factors in improving reuse (Hickey and Fitzpatrick, 2016). But there has been little discussion about policies to promote reuse.

* Corresponding author.
E-mail addresses: yangjx@rcees.ac.cn, yangjxm@gmail.com (J. Yang).

http://dx.doi.org/10.1016/j.resconrec.2017.07.012
Received 30 January 2017; Received in revised form 18 May 2017; Accepted 10 July 2017

Table 1
Terminology of reuse and related concepts.

Terminology	Definitions	Stakeholders	Possible processes included	Function/Warranty after processing compared to the original one	Definition Sources
Re-use/Reuse	Any operation by which products or components that are not waste are used again for the same purpose for which they were conceived	Repairman, collectors, resellers, other users, etc.	Checking, cleaning, repairing, etc.	Better, equivalent, or lower	(Borrman et al., 2009; EU, 2008; Standardization, 2007)
Preparing for re-use	The checking, cleaning, or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing	Repairman, collectors, resellers, other users, etc.	Checking, cleaning, repairing, etc.	Better, equivalent, or lower	(EU, 2008)
Reselling	The practice of selling a product to a secondary consumer when it reaches the end of its useful life for the original purchaser	Resellers, other users, etc.	Checking	Equivalent, lower	(Ruediger and Eric, 2003)
Repair	Return a faulty or broken product or component back to a usable state; Restore defective products to their intended state	Repairman, resellers, original users, etc.	Checking, repairing, etc.	Equivalent, lower	(BSI, 2009; VDI, 2014)
Recondition/Refurbish/ Rebuild/Reconstruct	Return a used product to a satisfactory working condition or a previously defined quality level, by rebuilding or repairing major components that are close to failure, even where there are no reported or apparent faults in those components	Repairman/Renovators, collectors, resellers, original users, etc.	Checking, repairing, etc.	Equivalent, lower	(Anonymous, 2012; BSI, 2009; VDI, 2014)
Upgrading	Enhance the properties, including inter alia its function, performance, and safety, by replacement of certain components or by other means	Repairman, renovators, collectors, resellers, original users, other users, etc.	Checking, upgrading, components replacement, etc.	Better, equivalent	(Ruediger and Eric, 2003; VDI, 2014)
Remanufacturing	Return a used product to at least its original performance with a warranty that is equivalent or better than that of a newly manufactured product	Collectors, Remanufacturers, resellers, other users, etc.	Checking, cleaning, disassembly, components replacement, repairing, re-assembly, etc.	Better, equivalent	(BSI, 2009; Helms and Goldstein, 1999)
Repurpose	Utilize a product or its components in a role that it was not originally designed to perform	Recyclers, collectors, resellers, other users, etc.	Checking, disassembly, components replacement, re-assembly, etc.	Different functions	(BSI, 2009)
Recovery	Any operation, the principal result of which is the waste serving a useful purpose by replacing other materials that would otherwise have been used to fulfill a function, or used as fuel in energy recovery	Recyclers, collectors, resellers, producers, etc.	Disassembly, shredding, sorting, refining, etc.	No product level functions	(BSI, 2009; EU, 2008)
Recycling	Any recovery operation by which waste materials are reprocessed into products, materials, or substances, whether for the original or other purposes	Repairman, collectors, remanufacturers, resellers, other users, recyclers, producers, etc.	Checking, cleaning, repair, components replacement, upgrade, remanufacturing, recovery, etc.	No product level functions	(EU, 2008)