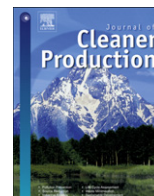


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Journal of Cleaner Production

journal homepage: [www.elsevier.com/locate/jclepro](http://www.elsevier.com/locate/jclepro)

## Review

## Perspective of electronic waste management in China based on a legislation comparison between China and the EU

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## ARTICLE INFO

## Article history:

Received 19 March 2012

Received in revised form

20 August 2012

Accepted 23 September 2012

Available online xxx

## Keywords:

Legislation

Comparison

Electronic waste

Perspective

China

The EU

## ABSTRACT

Illegal management of electronic product (e-product) from cradle to grave poses a huge threat to human and the environment, and the significant increases of electronic waste (e-waste) have violated the targets of previous regulations. To tackle these threats, a number of directives and regulations related to e-product and e-waste were promulgated, implemented and updated in China and in the European Union (EU) from 2006 to 2012. Comparing the relevant legislation along the e-product's entire life cycle between China and the EU, the prospect of e-waste management in China is presented. Some results and prospects have been reached: (1) the life cycle of e-product from forward logistics to reverse logistics is properly covered by the legislation framework both in the EU and in China. Within the reverse logistics of electronic product, EU legislation demonstrated a clearer and more systemic idea of eco-design and integrated product policy. More stakeholders are involved in China than the EU in the course of law enforcement; (2) the legislation differences between China and the EU can be attributed to the different cultural and social circumstances. The long-dated weak environmental awareness, many ministries and government hierarchies in China lead to the different frameworks and content from the EU; and (3) based on the comparison, a four-phase process of e-waste management in China is clearly outlined, including an informal manual dismantling phase (1980s–2000), recycling pilot phase (2001–2008), development phase (2009–2020), and mature phase (2020–).

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### 1. Introduction

Since 1990s, advances in technologies, rapid electronic product (e-product) updating, and shortening life cycles have led to a significant growth of waste electrical and electronic equipment (WEEE, also called e-waste). In Europe alone, a recent source estimates that the total amount of e-waste generation ranges from 5 to 7 million tons per annum and it is expected to grow at a rate of 3–5% per year, so that annual production of e-waste could reach 12.3 million tons by 2020 (UNU, 2008). And China has been a major manufacturer and consumer of electrical and electronic products, and has experienced huge increases in scrap material, which has resulted in the rate of growth of e-waste being three times higher than of the common waste (Wang et al., 2010). Obsolete household appliances (including televisions, washing machines, air conditioners and refrigerators) and personal computer equipment exceeded 160 million units in 2010, and the number is predicted to

exceed 225 million units in 2012, based on China's Plastics Statistics Yearbook 2006 (Huang et al., 2006; Li et al., 2006). Highly valuable materials in e-waste have driven recycling in unregulated centers with stripping of metals in open acid baths, removal of electronic components from printed circuit boards by heating over a grill, and recovering metal by burning cables and parts. These activities have caused severe pollution in the surrounding soil and groundwater in unregulated recycling areas, such as Guiyu in China (Bridgen et al., 2005; Leung et al., 2006; Ogunseitun et al., 2009).

Recognizing the importance of the e-waste stream and its potential impact on the environment, the EU introduced *Directive on Waste Electrical and Electronic Equipment* (WEEE directive) in 2002, and corresponding legislation in the EU Member States was in place in August 2005. The directive aimed to promote the reuse, recycling and other forms of recovery of e-waste to reduce the disposal of waste, and to improve the environmental performance of all operators involved in the life cycle of e-waste. However, the current collection target of 4 kg per person per year does not properly reflect the situation in individual Member States (Dindarian et al., 2012; Huisman et al., 2007). The WEEE directive was proposed in 2008 to set a new binding target for the collection

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of electrical and electronic equipment (Ongondo et al., 2011). The new mandatory collection target has been set at 65% of the average weight of electrical and electronic equipment placed on the market over the previous two years (EU, 2012). On the other hand, the Chinese government has been also aware of the environmental problems of e-waste for several years and issued a variety of environmental laws, regulations, standards, technical guidance and norms related to electronic product production and e-waste management (Li et al., 2006; Yu et al., 2010). At almost the same time as the EU, the Chinese government has been preparing legislation on e-waste, which was initiated by the National Development and Reform Commission (NDRC) and was also supported by other government agencies such as the Ministry of Environmental Protection (MEP) (Zhou and Xu, 2012).

In addition to the new legislations on e-waste, from environmental performance of life cycle for e-product, some directives and regulations related to e-product have been issued or updated from 2008 to 2011 in China and the EU. All these legislation could lead not only to more environmentally sound technology and management related to e-waste, but also result in smoother commercial trade of e-product among countries in the future. In this paper, we will compare the framework covering the relevant legislation related to the entire life cycle of e-product and e-waste, describe the implementation flows in the EU and in China, and further strive to outline the development process of Chinese e-waste management.

## 2. Life-cycle-management of e-product in China and the EU

### 2.1. Life cycle of e-product and major management legislation in China and the EU

The life cycle perspective is an elementary way to analyze the whole performance of products and determine what is environmentally sound at different stages in the life cycle (Boks and Stevels, 2007; Yellishetty et al., 2011). Perfect legislation should consider all the possibilities and cover all the different phases of a closed-loop chain (Queiruga et al., 2012). Thus, the perfection of the legal system should be evaluated with life cycle analysis of e-product, based on the closed-loop supply chains, shown in Fig. 1 (Georgiadis and Besiou, 2008; Hammond and Beullens, 2007). E-product can be manufactured and produced with extracted raw materials and semi-finished materials. Then, consumers or users can acquire the e-product via distribution. The process can be seen as forward logistics of e-product. E-waste is generated when the e-product has been used for the long time and approaches the end-of-life phase. The next process of e-waste from repair to disposal is widely recognized to be economically feasible in China (Liu et al., 2009). Some e-waste can be directly reused or repaired and transferred to the consumer again, and other e-waste can be collected by the formal or the informal sector (Yang et al., 2008). Averagely, around 60% of e-waste generated in China was sold to private individual collectors and passed into informal recycling processes. More than 90% of Chinese citizens are reluctant to pay for the recycling of their e-waste (Liu et al., 2006; Veenstra et al., 2010). After collection and dismantling of e-waste, some components can be manufactured into new e-product, and the residues can be recovered through mechanical treatment or incineration. Within those processes, some valuable components such as metals and plastics can go to the e-product stream again, and the residues are disposed through landfill. These phases can be seen as reverse product flows or reverse logistics of e-product (Sharma et al., 2007).

Many laws, directives and regulations on e-products and e-waste have been revised, updated or issued to enter into force in 2010 and 2011. The major laws or directives in China and the EU are indicated in Fig. 2. The legislation of e-product and e-waste was

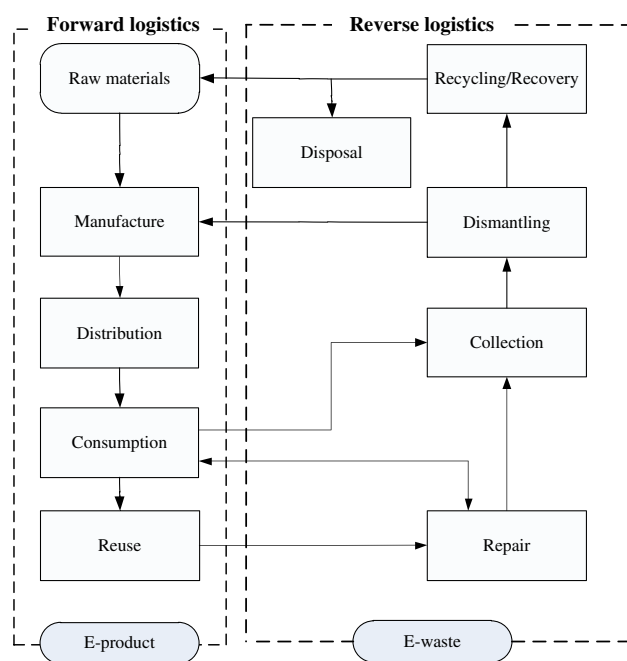


Fig. 1. Entire life cycle of e-product including forward logistics and reverse logistics.

introduced much earlier in the EU than in China. The EU was much better than China in the formal recycling of e-waste and in the establishment of licensed enterprises (Walther et al., 2010). The EU and China started to revise or enact legislations from 2005 to 2011. In the EU, some directives including *Directive 2005/20/EC on Packaging and Packaging Waste*, *Directive 2009/125/EC on Energy-related Products*, *Directive 2010/75/EU on Integrated Pollution and Control* and WEEE directive, have been revised following discussion. For instance, the European Parliament voted to revise the *Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS directive)* on November 24th, 2010, in order to improve implementation and enforcement, and to introduce greater coherence with other EU legislation, such as *Registration, Evaluation, Authorization and Restriction of Chemical Substances (REACH directive)* and the new legislative framework for the marketing of products.

In China, as mentioned above, the Ordinance on Management of Prevention and Control of Pollution from Electronic and Information Products (new China RoHS by Ministry of Industry and Information Technology (MIIT)) only came into force in 2007, and *Administrative Measure on Pollution Prevention of Waste Electrical and Electronic Equipments* was adopted in 2008 as a means to reduce source pollution and avoid severe pollution caused in the informal sector from 2000 to 2006. At the same time, *Administration Regulation for the Collection and Treatment of Waste Electric and Electronic Products* (China WEEE regulation by NDRC and MIIT) was passed by State Council. But an unexpected financial crisis postponed the implementation until January 1st, 2011. Prior to the China WEEE regulation, a temporary management policy for end-of-life household appliances including televisions, air conditioners, washing machines, refrigerators and computers, “*Old-for-New*” *Implementation Measures for Household Appliances* (State Council) was implemented to ensure the proper collection and treatment in advanced enterprises of most e-waste. This regulation was in place from June 1st, 2009–May 31st 2010, and it was then extended until December 31st, 2011 (Li et al., 2011). According to the statistics of Ministry of Commerce (MOC), the temporary policy had resulted that the following results:

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