Resources, Conservation & Recycling 127 (2017) 159–167

Contents lists available at ScienceDirect

Resources, Conservation & Recycling

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

Review

Operating models and development trends in the extended producer responsibility system for waste electrical and electronic equipment

Huaidong Wang[1], Yifan Gu[1], Liquan Li, Tingting Liu, Yufeng Wu*, Tieyong Zuo

Institute of Circular Economy, Beijing University of Technology, Beijing, China

ARTICLE INFO

Keywords:
Waste electrical and electronic equipment
Extended producer responsibility
Fund operating model
Eco-design
Voluntary producer responsibility

ABSTRACT

Waste electrical and electronic equipment (WEEE) has become a key application area for extended producer responsibility (EPR). This article systematically analyzes the physical and financial operating mechanisms of the EPR systems in Japan, Germany, Switzerland, and China, in addition to the responsibilities borne by the various stakeholders in the life cycle chain. Japan built a coupon system for household appliance recycling in which the consumers pay a fund after scrapping products. Germany built an operating model in which a fund is jointly managed by the national electronic equipment registry and the public waste management agencies. In Switzerland, a recovery fee accompanies the product invoice through various levels of resellers successively and is ultimately paid by the consumer. In China, the government occupies a leading position in putting EPR into practice. We compare the EPR operating mechanisms of the above four countries in terms of the time to pay fund, the fund payer, the object of fund subsidies, the fund operation agent. The differences and the pros and cons of them are analyzed. The result shows that although the operation mechanism of EPR system varies greatly in different countries, there are some common problems in promoting product eco-design, WEEE cascade usage and information value utilization. This article then looks ahead to the development directions of the EPR system in the field of WEEE recovery and utilization: (1) The coupling relationship between the EPR fund and other policy tools, such as promoting eco-design of products by production enterprises, should be investigated. (2) The secondhand market and remanufacturing enterprises should be brought into the EPR system to stimulate the formation of a cascaded cycle system of WEEE utilization. (3) The value of information on new product demands contained in WEEE should be exploited to build up a new business model with a positive supply chain for product manufacturing and consumption that closely corresponds to a reverse supply chain for WEEE recovery and utilization to accelerate the formation of voluntary producer responsibility.

1. Introduction

Since the 1970s, developed nations have entered an era of concentrated waste outbreaks; problems such as “cities besieged by garbage” not only generate significant environmental pollution but also pose higher demands on the government’s ability to govern and control public financial risks (Driedger, 2001; Gupt and Sahay, 2015). Extended producer responsibility (EPR) emerged in response to these needs. The earliest thoughts about this system can be traced back to the 1975 Swedish bill regarding waste recovery and management. This bill proposes that from an environmental protection and resource conservation perspective, producers are responsible for understanding the issue of how to treat discarded products using appropriate methods. Thus inspired, Thomas of Lund University in Sweden first officially formulated the concept of EPR in 1990, which solved the difficult problem of garbage disposal by making producers responsible for the entire life cycle of products; these responsibilities should include informative, physical, economic, liability and ownership responsibilities (Lindhquist, 2000). EPR is actually the concrete application of the “polluter-pays principle” in practice (Forslind, 2005). By clarifying the property right attribution of waste, a long-acting solution for the external problem of environmental pollution caused by waste was found. Under the guidance of this theory, EPR was applied first in Germany (Walther et al., 2010), Switzerland (Streicher, 2006), Canada (McKerlie et al., 2006), and other developed countries. Later, it gradually expanded to Brazil (Milanez and Bührs, 2009), India (Manomaivibool, 2009), Thailand (Manomaivibool and Vassanadumrongdee, 2011), China (Cao et al., 2016), and other developing countries.

In recent years, the scope of application for electrical and electronic equipment (EEE) continues to expand, and the speed of replacement

* Corresponding author.
E-mail address: wuyufeng3r@126.com (Y. Wu).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.resconrec.2017.09.002
Received 2 May 2017; Received in revised form 2 August 2017; Accepted 3 September 2017
Available online 27 September 2017
0921-3449/

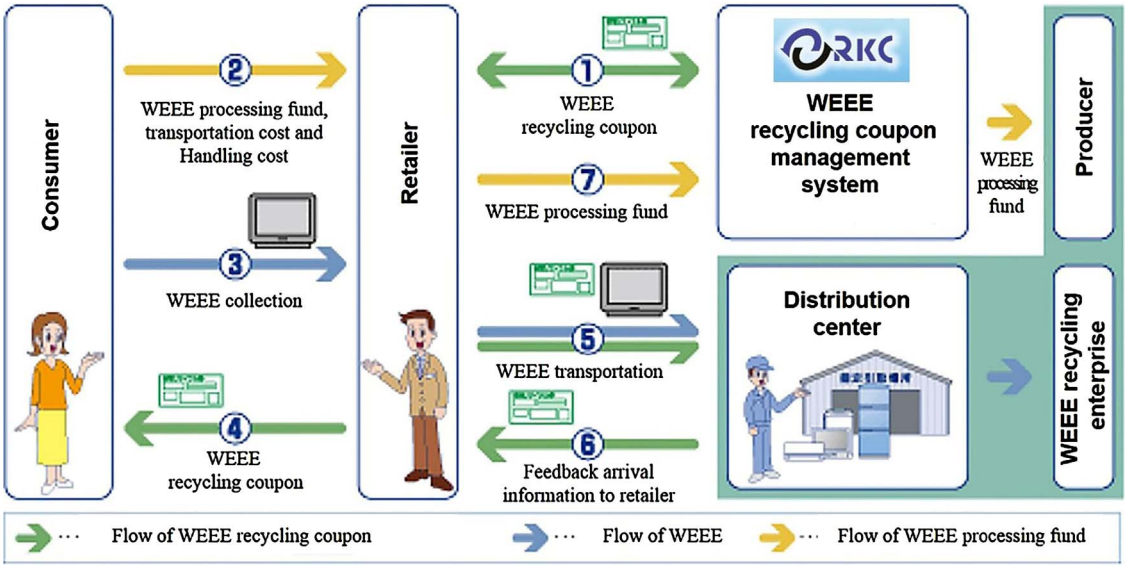

Fig. 1. The EPR system in Japan for WEEE recovery and recycling.
adapted from http://www.rkc.aeha.or.jp/text/r_procedure_s.html

continues to accelerate. The EEE manufacturing industry has become one of the world's largest scaled and fastest growing manufacturing industry types (Wath et al., 2010), subsequent to which is the high output of waste electrical and electronic equipment (WEEE) (Wang et al., 2013; Zeng et al., 2016a). According to statistics, WEEE constituted 8% of global urban waste as early as 2005 (Widmer et al., 2005), and its proportion has grown at a rate of 3–5% each year (Rahimifard et al., 2009); it is estimated that 40–70 million tonnes of WEEE were produced globally in 2015 (IIWM, 2013; Menikpura et al., 2014). WEEE is a potential source of all types of metal and organic matter; if used reasonably, it would doubtlessly be a high-quality urban mine(Liu et al., 2015; Tian et al., 2015; Wang et al., 2015). Meanwhile, WEEE also has the attribute of environmental pollution; if it is unreasonably recycled, it will cause great detriment to the environment (Chan and Wong, 2013; Sepúlveda et al., 2010; Wang and Xu, 2014). By virtue of its characteristics, such as large numbers in production, a lengthy recovery process, great disassembly difficulties, and high pollution intensity, WEEE has become a key application area for the EPR systems (Mayers et al., 2005). Because different countries have relatively great differences in national conditions, the specific methods of operation used to implement an EPR system in the field of WEEE recovery and utilization are not exactly the same. This article will systematically analyze the national conditions and operating mechanisms in the implementation of EPR systems in the four countries of Japan, Germany, Switzerland, and China, in addition to the responsibilities borne by the various stakeholders in the life cycle chain. Then we will compare the EPR in the above four countries in terms of the time to pay fund, the fund payer, the object of fund subsidies, the fund operation agent. Then the differences and the pros and cons of them and the development trends for EPR systems in the field of WEEE will be analyzed.

2. Application practice of EPR in four typical nations

2.1. Japan

Small land area and limited natural resources prompted Japan to put forward the slogan of "environment-oriented state" in the 1990s and to concentrate on formulating a series of laws and regulations regarding waste disposal, use of renewable resources, recycling of WEEE, and other related topics. For example, as early as 1998, Japan passed the first legislation in the world about the recovery of WEEE-*the Specific Home Appliance Re-commercialization Law*. In 2001, Japan formally implemented *the Electrical Home Appliance Recycling Act* by setting recycling indices for four WEEE types-refrigerator, television, air conditioner, and washing machine-from a legal perspective and began to practice new institutional means that fuse EPR with its national situation. Subsequently, Japan revised *the Act on the Promotion of Effective Utilization of Resources* in 2003 by including desktop computer and monitor, notebook computer, and other WEEEs in the scope of recycling targets and stipulating that enterprises include a recovery fee in the sales price when selling new EEE (Tojo, 2004).

Through legal restrictions, Japan has formed a consumer-paid EPR system. The law stipulates that the consumers are responsible for paying the series of costs in the transportation, regeneration, and recycling of WEEE, the producers should bear the responsibility for the WEEE regeneration and recycling, the retailers should bear the responsibility for the WEEE recovery and transportation, and the importers should recover the products that they have sold. The transportation cost from the consumer to the retailer and from the retailer to the distribution center is determined based on the retailer's own fee standards and paid by the consumer separately (Chung and Suzuki, 2008).

To better coordinate the responsibilities of the various stakeholders in the entire chain of WEEE recovery and recycling, Japan also expressly established a Home Appliance Recycling Coupon Center (Recycling Ken Center, RKC) to connect the various stakeholders with each other via issuing recycling coupons (AEHA, 2015). As shown in Fig. 1, the consumer needs to obtain a recycling coupon and adhere it on the body of the WEEE when trading in them to the retailer. This coupon successively follows the WEEE though recovery, transportation, and other links to enter a designated distribution center for archiving, and a specially assigned person records the recovery and recycling situation of the WEEE in a corresponding system; the WEEE processing fund is ultimately collected at the RKC through the retailers. The RKC issues funding subsidies to WEEE recovery and processing sites according to the information on the recycling coupons (AEHA, 2016).

To guarantee the smooth operation of recovery in the recovery links, Japan established a sound WEEE recovery network that divided the entire country into 10 major areas. As of July 2016, Japan has already formed a comparatively complete recovery processing system, with a total of 349 large-scale distribution centers and 46 resource regeneration and utilization processing bases (AEHA, 2016). To avoid duplicate building of recovery systems among enterprises and promoting the formation of competitive relationships, Japan has already