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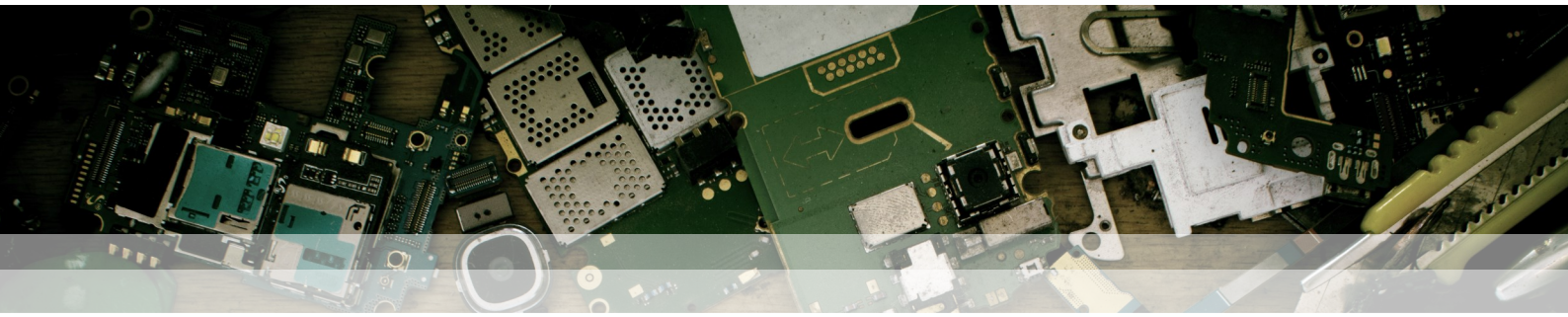
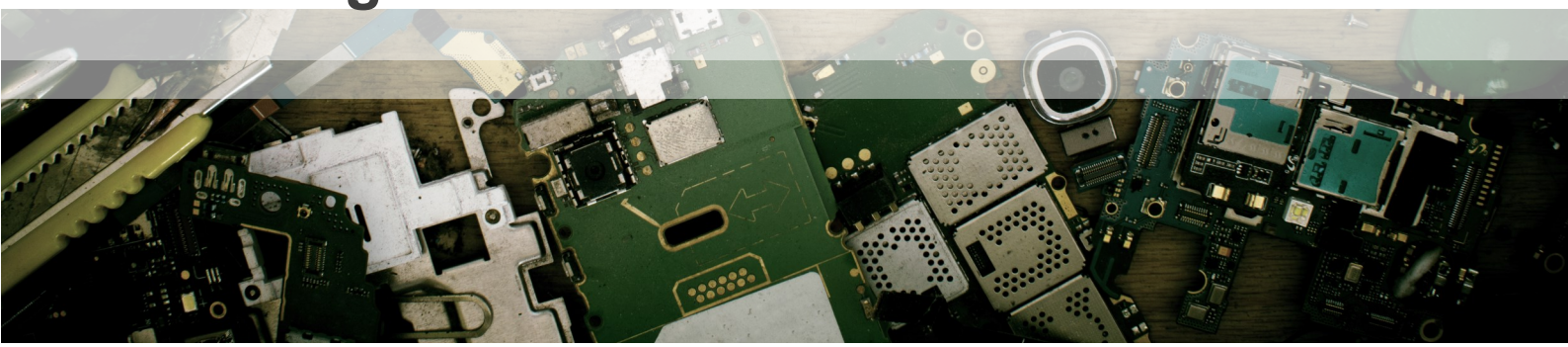


Sustainable Development Goals Policy Brief Series No.7

E-waste Management in Korea: Focusing on Seoul



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Sustainable Development Goals Policy Brief Series No.7

E-Waste Management in Korea: Focusing on Seoul

Acronyms

E-waste	Electronic waste
EU	European Union
EU RoHS	EU Restriction of Hazardous Substances
EPR	Extended producer responsibility
KERC	Korea Electronics Recycling Cooperative
MOE	Ministry of Environment
SMG	Seoul Metropolitan Government
UNDP	United Nations Development Programme

Table of Contents

Figures and Tables

Figures

Tables

Executive Summary

Electronic waste (e-waste) is defined as any discarded electrical or electronic device, including household appliances, phones, and computers. E-waste generation has grown exponentially in the last 30 years and has emerged as one of the major environmental concerns of our times. The improper handling of e-waste can lead to hazardous toxins permeating water, soil, and air, resulting in environmental degradation and adverse effects on public health. Furthermore, safe processing of e-waste requires a higher technical skill set, in comparison to general waste. Due to these factors, e-waste management requires extensive legislation, strong regulations, effective implementation of policies and well-equipped, technologically advanced facilities for recycling.

The Government of Korea has consistently responded to the changing landscape of e-waste management and has continuously expanded relevant legislation, making it a noteworthy case study. This paper discusses the historical development of e-waste legislation and recycling systems in Korea starting from the Producer Deposit-Refund system. Introduced in 1992, this system initiated the outsourcing of e-waste handling to skilled private recyclers. However, as the amount of e-waste rapidly increased, new programs were introduced, including the Producer Recycling System which placed the responsibility of e-waste recycling on the manufacturers. This was followed by a volume-based user fee system, that gave local districts the authority to charge fees for e-waste collection. In 2003, the Producer Recycling System was replaced by the Extended Producer Responsibility system. This new system proved to be more successful as it lowered the recycling costs for producers and consequently increased the amount of e-waste that was recycled.

From 2008, the government expanded producer responsibilities in e-waste management and producers committed to minimizing waste generation during the production process. In 2014, Korea once again redefined recycling criteria and created the Electrical and Electronic Product Eco-Guarantee system. This system broadened the responsibility of e-waste recycling from the manufacturers to a nationwide endeavor.

The Ministry of Environment in Korea oversees a diverse set of partners throughout the recycling process. These partners include the Korea Electronics Recycling Cooperative, which plays a vital role in managing and coordinating a free-of-charge collection service network. Another important partner, the Korea Environment Corporation monitors the implementation of recycling programs and runs training programs aimed at improving resource efficiency in waste management. The Ministry of Environment is also responsible for the development of treatment technologies and setting technical standards to ensure proper e-waste treatment.

The Korean experience demonstrates how regulations and safeguards can be effectively developed and enforced by the government for safe e-waste recycling. Moreover, the government continues to expand legislation and introduce new programs and systems to improve e-waste recycling and facilitate proper disposal. This paper suggests that the development of Korea's e-waste management framework may provide insight into initiatives that can be adapted to different country contexts along with legislative experiences that can be useful benchmarks.

1. Changes in E-waste Management

In the Republic of Korea (hereinafter referred to as "Korea"), all waste is categorized into two groups: residential or business waste. Electronic waste (e-waste) is classified as either residential or business waste depending on its source or origin. Korea generates approximately 0.8 million tonnes of e-waste per year. E-waste is collected through several routes managed by producers and local municipalities. In most cases, waste is disposed of at recycling facilities.

According to the Ministry of Environment (MOE) of Korea, in 2014, about 17 to 31 tons of e-waste was collected and recycled in Seoul daily (see Table 1). Therefore, the average citizen of Seoul produced roughly 1.03 kg of e-waste per capita*. In comparison to the European Union's (EU) e-waste recycling target of 6.1 kg per capita, the amount of e-waste produced and recycled in Seoul is substantially lower. Presumably, this is because the amount shown in Table 1 only covers e-waste collected by 25 local districts**, and does not include the e-waste collected by non-governmental agencies such as collection services provided by producers, free-of-charge collection services under Korea Electronics Recycling Co-operative (KERC), or private recyclers (junk shops***). Therefore, it is difficult to quantify the actual generation of e-waste based on government and local district data alone. The table below presents waste generation(ton/day) and recycling rate for 2010-2014 in Seoul.

Table 1. Status of E-waste Management in Seoul

Items	2010	2011	2012	2013	2014
Generation (ton/day)	35	27	27	31	17
Landfill (%)	-	-	-	-	-
Incineration (%)	-	-	-	-	-
Recycling (%)	100	100	100	100	100

Source :Ministry of Environment, 2015

Beginning in 1992, e-waste was collected and disposed of by private recyclers under the 'Producer Deposit-Refund' scheme (Honda et al., 2016). Since e-waste is generally bulkier and heavier than other types of waste, the handling of e-waste was outsourced to skilled private recyclers. However, as e-waste generation increased, and the need for proper recycling became widespread, the government introduced a waste deposit system, known as the 'Producer Recycling System'. This system assigned the responsibility of recycling on producers. In 1995, with the implementation of a volume-based user fee system, local districts were given the responsibility to collect e-waste and the authority to collect e-waste user fees. A series of policies adopted starting from 1993 expanded the range of e-waste collecting bodies to include producers, local districts, and private recyclers.

*Calculated internally

**There are 25 local districts under the Seoul Metropolitan Government (SMG), and each local district is responsible for supervising separate discharge of waste (Yoo Kee-Young, 2017)

***Junk shops refers to shops that sell e-waste as secondhand goods after collecting and repairing them (Yoo Kee-Young, 2014)

The original Producer Recycling system had a minimal effect on encouraging producers to actively engage in the e-waste collection process. This system obligated producers to deposit funds based on their production performance, and allowed them to get the deposit back depending on the amount of e-waste they collected and treated. However, majority of producers chose not to participate and opted to let go of their deposits. Thus, the recycling rate from the producer side was initially very low.

In 2003, the Producer Recycling system was replaced by the 'Extended Producer Responsibility (EPR)' system. This EPR system set mandatory goals for recycling and penalized producers who failed to follow through on their responsibilities. Producers recycled electronic waste through their own system or by contracting out to agents. The EPR system lowered the recycling costs for producers and increased the amount of e-waste recycled.

Since 2008, the government has expanded the scope of duties for producers in two ways; first, by making producers responsible not only for recycling but also for keeping waste generation to a minimum during the production process; second, by increasing the number of items covered by the EPR system. These revisions were partially encouraged by changes made by Korea's major trading partners. The EU, the U.S., Japan, and China began to competitively regulate the use of hazardous substances in electrical and electronic products, increasing the recyclability of materials used in production. These regulations encouraged Korea to introduce the 'Electrical and Electronic Product Eco-Guarantee' system, which governs the lifecycle of products from production to disposal.

Beginning in 2014, Korea moved away from a recycling criteria based solely on the number of products to one standard that measured recyclables on a kilogram-per-capita basis. This signified an important change in the recycling system, making it easier to compare Korea's recycling status with that of other advanced countries. Moreover, the creation of the 'Electrical and Electronic Product Eco-Guarantee' system broadened the responsibility of e-waste recycling from just producers to a nationwide endeavor led by the Korean government. KERC played a vital role by managing the recycling of e-waste through a free collection service network where consumers could easily arrange to have e-waste safely disposed. The policy changes brought about by the 'Electrical and Electronic Product Eco-Guarantee' system and encouraged collaboration among stakeholders (producers, KERC, private recyclers, and local districts) on handling e-waste collection.

2. Related Parties and their Roles

Producers play an integral role in e-waste management in Korea. They can recycle e-waste through their own collection and processing system, or outsource recycling to external operators. Most producers in Korea opt for the second option, collaborating with contractors to fulfill their responsibilities. The collection of e-waste is carried out by delivery services provided by producers, free-of-charge collection services under KERC, local districts, and private recyclers. The Korean government oversees these partners throughout the process, developing treatment technologies and setting technical standards to ensure that e-waste is handled properly. The MOE monitors producers to ensure they implement their obliga-

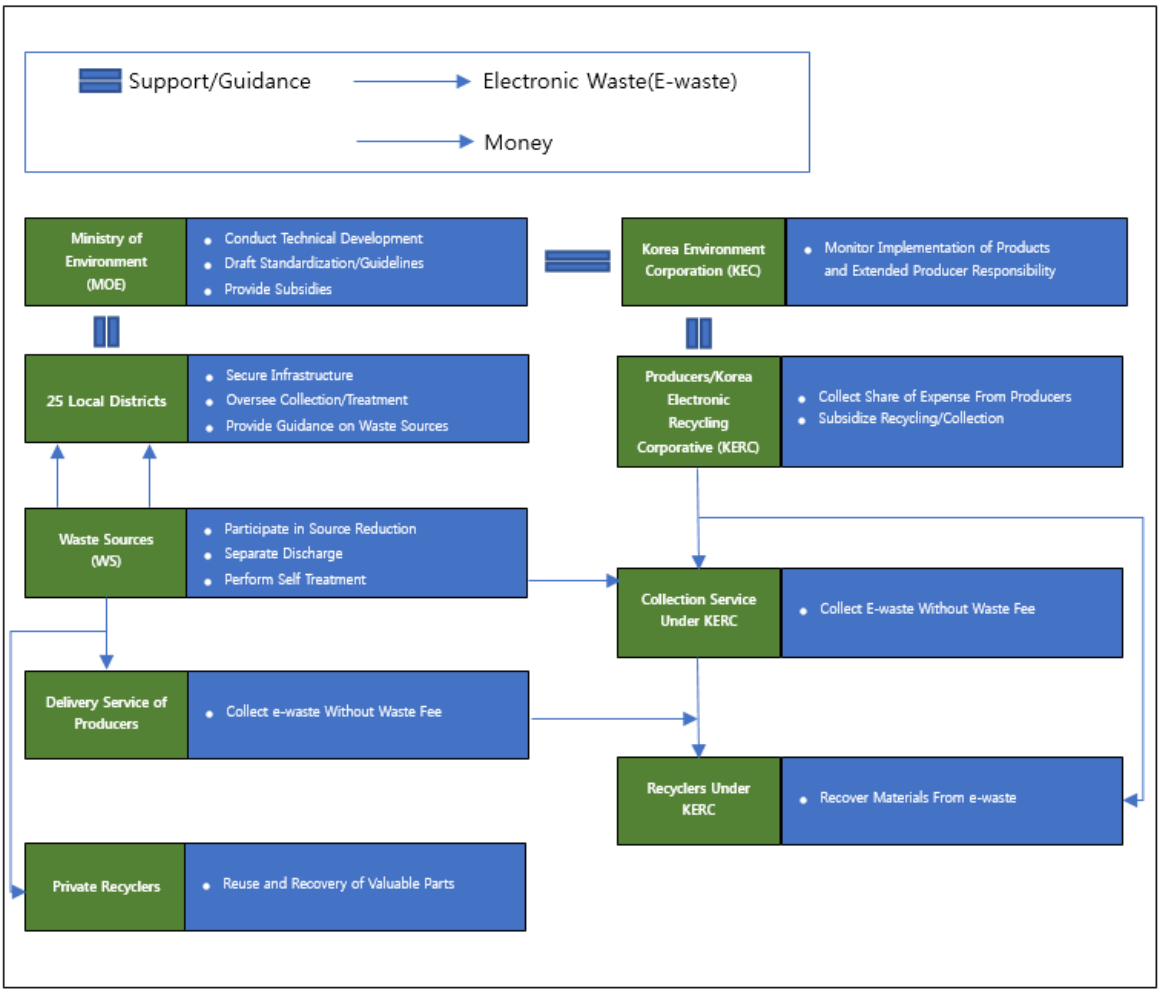
tions into their policies and also imposes penalties if they fail to meet e-waste collection goals. In turn, the Korea Environment Corporation (K-eco) monitors producers' implementation of recycling programs and also runs management training programs for improving resource efficiency in waste management.

Producers tend to collect e-waste when newly purchased products are delivered to the consumer through the delivery service provided by the producer. Meanwhile, KERC's free collection service provides a reservation system where users make an appointment online or by phone to have KERC pick up the e-waste on a specified date. Electronic waste that is not collected by private recyclers is brought into designated recycler facilities managed by KERC. The waste treated in these facilities is sold after being disassembled.

Local districts collect e-waste only when the consumer of the waste pays a user fee. The 25 local districts in Seoul are responsible for guiding consumers on how to properly dispose of the e-waste, establishing regulations on the discharge, and setting a collection system for the waste. The Seoul Metropolitan Government (SMG) has installed and operated the Seoul Recycling Centre to help with the treatment of small e-waste collected from the 25 local districts. However, compared to other residential waste such as food waste, the role of SMG in e-waste collection is rather limited since producers assume the majority of the responsibility.

Private recyclers collect electronic waste to earn profits by repairing, disassembling and extracting valuable parts. However, as e-waste recycling becomes increasingly regulated, many private recyclers are dissuaded from contributing to this process. This has led to a decrease in the total amount of e-waste collected by private recyclers.

Figure 1. E-waste Management: Related Parties and their Roles



Source: Yoo Kee-Young, 2017

3. Extended Producer Responsibility (EPR) system

3.1 Transitioning from the Producer Recycling System to Eco-Guarantee System

The Korea Electronics Recycling Cooperative (KERC) estimates that 80% of electronic waste in Seoul is collected through delivery services provided by the producers and its own free-of-charge collection service.

Before the introduction of the Extended Producer Responsibility (EPR) system in 2003, the Producer Recycling system was the principal method of handling e-waste in Korea. The Producer Recycling system relied on economic incentives based on deposits. The deposit was based on each producer's production per kilogram. The amount returned to producers was dependent on the amount of e-waste that was collected and treated. However, the system was not effective as the rate of deposit return remained low and the category of goods covered was limited to TVs, washing machines, air conditioners, and refrigerators (Korea Consumer Agency, 1998). Faced with these challenges, the Korean government replaced the Producer Recycling system with the EPR system in 2003.

Through the EPR system, the government sets a recycling goal for each product and imposes a penalty in proportion to the amount of waste that was not recycled. Each producer can choose their preferred method of e-waste management, either by running their own collection and treatment system, or by outsourcing the task to KERC. Following the adoption of the EPR system, the list of applicable products was expanded to include personal computers, printers, copiers, fax machines, mobile phones, and audio equipment. In order to ensure a more eco-friendly recovery process, Korea transitioned from the EPR system to the Eco-Guarantee system in 2008, and shifted the focus from meeting recycling goals as a percentage to recycling amounts (kg per capita) in 2014.

With the introduction of the Eco-Guarantee system, the responsibility of producers was expanded from simple recycling to utilizing production processes that are more environmentally friendly. The Eco-Guarantee system was implemented to reflect international trends regarding the use of toxic substances in the manufacturing of products (e.g., EU Restriction of Hazardous Substances or EU RoHS). For example, manufacturers of washing machines and televisions were required to reduce the use of toxins such as lead, mercury, hexavalent chromium, polybrominated biphenyls, and polybrominated diphenyl ethers. The Eco-Guarantee system encouraged producers to ensure that 95% of the total weight of their products should be recycled with energy recovery limits set below 10%. In addition, the Eco-Guarantee system encouraged e-waste recycling to take place only in accredited facilities that meet performance standards set by the government. The rules enforcing the Eco-Guarantee system are provided in the *Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles, 2010*.

Such policy shifts under the Eco-Guarantee system encouraged an uptake in the amount of products recycled. The rate of recovered electronic waste greatly improved for different product categories, particularly TVs, fax machines, refrigerators, and washing machines (Shin et al., 2014).

Currently, businesses subject to the EPR system in Korea include producers with annual sales of over 1 billion KRW, importers with more than 300 million KRW, and sellers with annual sales of over 5 billion KRW. In 2014, there were 533 producers and importers, along with 269 sellers under the EPR system. The table below outlines the changes in Korea's recycling system including changes to product coverage and recycling processes since 1993 onwards.

Table 2. Changes in the Korea's recycling system of e-waste

Items	Producer Recycling system	Extended Producer Responsibility system	Eco-Guarantee system
Period	1993-2002	2003-2007	2008-present
Products covered	- Large appliances (i.e. TVs, washing machines, air conditioners)	- Large appliances, office equipment (i.e. PCs, printers, copiers), and some small appliances (i.e. mobile phones)	- Large appliances, office equipment, medium appliances (i.e. electric water purifiers, electric ovens, microwaves), and small appliances (i.e. electric bidets, air purifiers, electric heaters)
Process	- Deposit of product per kg. - Deposit refund if recycling target is achieved	- Government presents a recovery goal - Fines are imposed on producers who fail to meet the recovery target	- Government manages the environmental aspect of products and the recovery process of the E-waste - Government presents a recovery goal - Fines are imposed on producers who fail to meet the recovery target
Recycling goal		- Recycled amount (%)	- Recycled amount (kg/capita)

Source: Yoo, Kee-Young, 2017.

3.2 Recycling Goal Management Programme

In 2003, the EPR system was introduced, it mandated that products be recycled on a per item basis, but was applicable to only 10 items*. While well-intentioned, this item-based management system proved ill-equipped to cope with new technological products that flooded the market during the mid-to-late 2000s. As a result, Korea was falling behind other developed countries in terms of e-waste recycling. Data from 2012 clearly demonstrates the limitations of the EPR system as only 2.9 kg of e-waste per capita was recycled in Korea, compared to 7.1 kg in the EU.

*TVs, refrigerators, washing machines, air conditioners, personal computers, audio speakers, cellular phones, printers, copiers, and fax machines. (Mincheo Kim et al., 2012)

To address these challenges, the government passed the 'Recycling Goal Management Programme' in 2014, which assigned recycling goals to product categories instead of individual items. This program was introduced in accordance with the *Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles (2010)*, which assigns recycling goals to producers on a per-capita basis.

In 2018, the Korean government announced that it will increase its recycling target from 3.2 kg per capita to 6 kg per capita, following the EU's efforts to strengthen its own recycling efforts. The EU set a recovery goal of 65% by 2019, with a range of 116 products and 10 product groups (European Recycling Platform). Statistics from the Ministry of Environment (MOE) and the Korea Electronic Recycling Cooperative (KERC), show that approximately 93% of the e-waste collecting and recycling target was met in 2017. However, despite these impressive results, the MOE target of 8.6 kg per capita per year by 2023, will require an even more efficient collecting system and increased recycling plant capacity (Park et al., 2019).

3.3 Free-of-Charge Collection Service

Prior to 2014, there were three main partners responsible for collecting electronic waste: delivery services provided by producers, local districts, and private recyclers. However, the collection and treatment method used by the local districts and private recyclers was problematic. Local districts would often move waste even when the user fee had not been paid, and it was also difficult to keep track of collected e-waste. Also, private recyclers treated e-waste at facilities that lacked proper treatment technology, resulting in environmental problems. For example, refrigerant*, is a known greenhouse gas contributor requiring proper equipment for separate collection under very specific conditions. However, due to a lack of guidance, most private recyclers disassembled coolers without taking cautionary measures or using proper equipment. This resulted in refrigerant escaping into the surrounding environment and contributing to greenhouse gas emissions. In 2014, to address this challenge in the treatment processes of local districts and private recyclers, the MOE began a free collection service for large household appliances in collaboration with KERC.

In practice, KERC manages the service, but the actual reservation-collection process is outsourced to RCL (Korea) Ltd., a company specialized in recycling. Weeclogics, a logistics company, is responsible for transporting electronic waste from the collection area to the specified recycling area. A variety of large and small items can be collected under the free collection service, ranging from washing machines to air purifiers. The programme started as a pilot project in Seoul in 2012 and by 2013 it was expanded to other major cities such as Busan, Daegu, Daejeon, and Gwangju. In 2015, e-waste collected under this system was estimated to be about 780,000 units, comprising about 20% of the total waste recycled. This number has rapidly increased, with 1,220,000 units in 2016 and 1,580,000 units collected in 2017 (Ministry of Environment, 2017).

*Refrigerant is a substance used in the heat pump and refrigeration cycle

3.4 Public Awareness

By providing free e-waste collection services across the country, the Korean government is attempting to minimize the use of unlicensed recycling operators and the unsafe disposal of e-waste. However, the effectiveness of the KERC's free-of- charge collection service requires not only resources and logistical capacity, it also requires widespread public participation.

Furthermore, public awareness is a crucial factor for promoting extensive participation. Citizens need to be aware of e-waste regulations, the availability of services and how to use those services. A study by Park et. al, surveyed 2000 respondents over three years (2015-2017). They found that nearly 50% of respondents were aware of KERC's free-of-charge collection service, and that this percentage has been steadily increasing every year (Park et al., 2019). Additionally, 91% of the users of the service expressed a positive opinion, highlighting the "free" service as a positive aspect. The 964 respondents (who had used the service) were also asked, how they first became aware of the service. The response cited included mass media (24%), followed by promotional literature (19%), promotional materials distributed by KERC, and inquiries to local government (19%). The two next highest sources were very similar with respondents scoring acquaintances at 15% and internet searches at 14%. The two lowest sources included blogs & social media (4%), and others/don't recall (5%)" (Park et al., 2019).

The paper found that satisfaction among service users was high, with 91% expressing that they were either satisfied or very satisfied with the service. As noted, the survey revealed that the greatest perceived advantages of the service were that it was "free of charge (44%) and that it provided a direct contact system between customers and visiting engineers (27%). Three additional reasons were cited at a similar rate, including provision of speedy customer service (9%), the ability to adjust the visiting schedules (8%), and convenience (8%)" (Park et al., 2019). Based on these findings, the study noted above concluded that public awareness was growing among citizens about this particular KERC service. They however, recommend greater publicity especially a greater online presence (Park et al., 2019).

The following table presents details about the free-of-charge collection service in Korea as of 2018.

Table 3. Outline of Free-of-Charge Collection Service of Electronic Waste in Korea

	Contents
E-waste item	-Refrigerators: household fridges, business fridges, kimchi fridges, wine refrigerators, showcases, and household freezers -Washing machines: general, drum, and dehydration types; dryers -Air conditioners: indoor, outdoor, integral, and ceiling types -TVs: Cathode ray tube, plasma display panels, liquid crystal display, and projection TVs -Other appliances: electric oven ranges, dishwashers, water purifiers, vending machines, air purifiers, treadmills, copiers, microwaves, audio equipment, and PCs -Small household appliances: electric rice cookers, electric fans, vacuum cleaners, printers, fax machines, electric heaters, and monitors
Service area	-2012 : Seoul -2013 : Seoul, Busan, Daegu, Daejeon, Gwangju -2014 : Nationwide
Process	-Process : reservation → selection of date → notification of visit → collection -Reservation : mobile (1599-0903), online (www.15990903.or.kr), Social media (KakaoTalk*)
Management	-KERC: whole system management -RCL: private company responsible for reservation system and collection of e-waste -Weeclogics: private company responsible for transportation

Source: Korea Electronics Recycling Cooperative, 2018.

* Kakao Talk is a messaging application widely used in Korea and is also accessible worldwide.

4. Collection and Treatment

Electronic waste is collected by producers, KERC, local districts, and private recyclers. KERC estimates that 60% of total collection comes from the delivery service provided by producers, 20% from its own collection service, and the remaining 20% from local districts and private recyclers.

Producers collect electronic waste through approximately 3,300 authorized retailers. Furthermore, there are 85 storage facilities for transportation and/or recycling needs. Meanwhile, the free collection service under KERC and local districts has its own recycling depository which transports the collected e-waste to recycling facilities. Since the recycling process among private recyclers is generally difficult to regulate, the *Waste Management Act* forbids private recyclers from treating electronic waste. Nevertheless, there are private recyclers that continue to collect and treat electronic waste.

KERC treats e-waste collected by producers and its own collection service, along with local districts by working with 9 public and 44 private recycling facilities. This is particularly important since these facilities have the necessary training to recover valuable metals and handle toxic substances that could harm the environment.

Figure 2. Example of E-waste Discharge Sticker

Source: *Asia Today*, "E-waste discharger sticker", 2015.

The following table outlines provisions from the *Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles (2015)*, highlighting the materials that must be recovered during the recycling process and the implementation of mandatory recycling rates for various items.

Table 4. Regulations on Electronic Waste Recycling

Items	Recycling principles
Common products	-Reuse and recycling of parts after processing treatment (disassembling, compression, crushing, and cutting) -Recovery of valuable metals from the printed circuit boards
Large scale appliances	-Recovery of chlorofluorocarbons from refrigerators, air conditioners, and vending machines -Implementation of mandatory recycling rate (weight base) of over 65% for the television (except for liquid crystal displays and plasma display panels), over 70% for refrigerators and vending machines, and over 80% for washing machines and air conditioners
Office equipment	-Recycling of personal computers -Implementation of mandatory recycling rate (weight base) of over 65% for PCs, over 75% for printers, copiers, and fax machines, and over 70% for mobile phones
Medium scale appliances	-Recovery of chlorofluorocarbons from electric water purifiers -Implementation of mandatory recycling rate (weight base) of over 75%
Small scale appliances	-Recycling of electric heaters -Implementation of mandatory recycling rate (weight base) of over 75%

Source: *Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles, 2015*.

4.1 Collection Facilities in Public Spaces

Among other provisions the *Act on the Promotion of Saving and Recycling of Resources* stipulated that batteries must be collected separately from other forms of waste to increase rate of collection and recycling of waste batteries, which stood at 5% nationwide in 2008. Since then, the MOE has installed recycling bins for batteries and other materials such as florescent light bulbs, across the country. These recycling bins have been installed in a variety of public places, including apartment complexes, subway stops, parks and community centers. Figure 3 shows a recycling bin for both batteries and cell phones located in a subway station in Seoul.

Figure 3. Recycling Bin for Batteries

Photo credit: UNDP Seoul Policy Centre, 2019

Figure 4. Districts of Seoul

Source: Seoul Metropolitan Government, 2019 http://english.seoul.go.kr/get-to-know-us/city-hall/organization-chart/5-districts/

Table 5. Recycling Bins for Batteries (Seoul) in 2019

Administrative Sub-unit	Average per Sub-unit	Location			
		Total	Apartment Complex	Road	Residential area
424	15.5	6,577	4,223	1,186	1,168

Source: Seoul Metropolitan Government http://opengov.seoul.go.kr/sanction/18569521?tr_code=open

In terms of implementation, administrative sub-units are responsible for installing these recycling bins in their jurisdiction*. As of 2019, a total of 6,577 bins have been installed, with an average of 15.5 battery recycling bins per administrative sub-unit. These easily accessible recycling bins have resulted in an increase in battery collection and recycling. The table 6 shows a yearly increase in battery collection from 2014-2018.

*There are 25 autonomous "gu" districts in Seoul, divided into 424 administrative "dong" sub-units in Seoul. For example, UNDP Seoul Policy Centre is located in Seongbuk-gu, 5 Anam-dong. Each "gu" is a basic local government unit that takes care of it's assigned affairs and autonomous duties. The "gu" provides administrative services at the local level (https://www.seoulsolution.kr/en/content/statistic-seoul).

Table 6. Number of Batteries Collected

	2014	2015	2016	2017	2018
Nationwide (Yearly increase %)	1,823 tons	2,221 tons (21.8%)	2,495 tons (12.3%)	2,982 tons (19.5%)	3,087 tons (3.5%)
Seoul (Yearly increase %)	357 tons	423 tons (18.5%)	450 tons (6.4%)	512 tons (13.8%)	522 tons (2.0%)

(Unit: ton/year) Source: Seoul Metropolitan Government, 2018 http://opengov.seoul.go.kr/sanction/18569521?tr_code=open

Furthermore, public transit in Korea uses a smart card system which operates on Radio Frequency Identification (RFID) technology. Though majority of people use rechargeable smart cards to pay for transportation fares in and around Seoul, there are also Single Journey Tickets that use the same technology. Therefore, to promote the recycling of Single Journey Tickets, a 500 KRW* deposit is required when purchasing them. This deposit is refunded later when the ticket is returned. This system is meant to incentivize users to return the ticket so that it can be recycled. There is also the option of donating that deposit by returning the ticket to a donation box. The pictures below show, a deposit refund machine and a donation box for Single Journey Tickets, that can be found in a majority of subway stations.

Figure 5. Recycling Single Journey Tickets

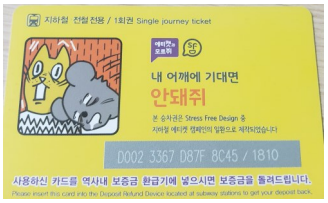
Single Journey Ticket	Deposit Refund Machine for Single Journey Tickets	Donation Box for Single Journey Tickets
		

Photo credit: UNDP Seoul Policy Centre

*500 KRW is roughly 0.45 USD in November 2019.

5. Seoul Recycling Centre

Unlike large-scale household appliances, small-scale appliances were traditionally discarded without proper treatment. As a result, most small-scale electronic waste items were not recycled in an eco-friendly manner, and often incinerated, crushed, or even exported illegally. To address this problem, SMG established the 'Seoul Recycling Centre' where small-scale appliances and mobile phones could be recycled.

The centre has an area of 2,774m^2 and includes a decomposition room, training room, and a warehouse. Currently, the centre is operated by 'Eco City Seoul,' a social enterprise that provides employment opportunities to socially disadvantaged people. Operating expenses are covered by the sale of recovered parts, subsidies from KERC, and financial assistance from SMG. In 2013, for example, the centre recycled 180,000 mobile phones and 1,537 tons of electronic waste.

Types of electronic waste brought into the centre includes cleaning equipment, rice cookers, computers, electric fans, and heaters. The products are classified and disassembled according to material type and then sold to secondary processing companies through an open bidding process. The most important factor considered during the bidding process is whether the competing companies are certified by the government to recycle and dispose of waste. Also, companies selected during the bid are required to sign an agreement that the recycled materials will not be exported and will be utilized within Korea (Jeong, 2014).

Figure 6. Seoul Recycling Centre

Seoul Recycling Centre building

Disassembly process at the centre

Source: Seoul Recycling Centre, 2018.

6. Financing

Under the EPR system, producers are responsible for all the costs generated during recycling. Producers' share of expenses for e-waste recycling differ by categories as shown in Table 7 — mobile phones are the highest at 303-325 KRW/kg while the cost of large-scale appliances is relatively low at 28-91 KRW/kg. Operating mobile phone recycling facilities is expensive since recycling technology and infrastructure is still in its early stages. Treatment costs include the costs of dismantling and categorizing e-waste, while taking into consideration profits acquired from the resale of material components. Large-scale and medium-scale appliances are usually cheaper to process because profit from reselling the waste covers most of the costs. In contrast, small-scale appliances have higher processing costs because they do not have much material content that can be resold. For instance, electric fans consist mostly of plastic and not much else with resale value.

The 25 local districts in Seoul collect user fees from e-waste consumers to cover the costs of collecting waste and furniture. The authority to collect user fees is outlined in each local districts code and every local district can set their own rates for user fees. User fees vary by item and size (see Table 8). In 2014, the 25 local districts in Seoul spent 9.5 billion KRW on the collection and disposal of electronic waste, with collected user fees amounting to 8.5 billion KRW, therefore covering 90% of total expenses (MOE, 2015). The difference was paid for by the local districts' general revenue.

Table 7. Distribution of Expenses for E-waste Recycling between Producers and Sellers (based on 2016, KRW/kg)

Items		Large scale appliances		Office equipment		Medium scale appliances		Small scale appliances		Mobile phones	
		Producer	Seller	Producer	Seller	Producer	Seller	Producer	Seller	Producer	Seller
Collection	Collection	16	16	94	94	38	38	34	34	94	94
	Transportation	15	-	18	-	23	-	21	-	18	-
	Sum	31	16	112	94	61	38	55	34	112	94
Treatment		-	-	4	-	-	-	87	-	4	-
Project	Common	2	2	2	2	2	2	2	2	2	2
	Individual	-	-	1	-	-	-	3	1	197	197
	Free Collection Service	48	-	18	-	16	-	12	-	-	-
	Sum	50	2	21	2	18	2	17	3	199	199
Maintenance		10	10	10	10	10	10	10	10	10	10
Total		91	28	147	106	89	50	169	47	325	303

Source: Korea Electronics Recycling Cooperative, 2016.

Table 8. User Fees for E-waste in Seoul, Jongro-gu District

Items	Details
Refrigerators	For businesses: 15,000 KRW For households: - Over 500L: 11,000 KRW - 300L-500L: 8,000 KRW - Under 300L: 6,000 KRW
Washing Machines	5,000 KRW
Air Conditioners	For businesses: 15,000 KRW For households - Over 264㎡: 11,000 KRW - 66㎡-264㎡: 8,000 KRW - Under 66㎡: 5,000 KRW
TVs	Over :42'' (inch): 7,000 KRW From :25''-42'': 4,000 KRW Under: 25'': 3,000 KRW

Source: Ministry of Environment, 2015.

7. Related Laws

The discharge, collection, and treatment of electronic waste is covered by various laws including the *Waste Management Act* passed in 1986, the *Act on Saving and Recycling of Resources* passed in 1992, and the *Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles* passed in 2007. The *Waste Management Act* provides the general principles for disposal (incineration or landfill) and the recycling of electronic waste. The *Act on Saving and Recycling of Resources* deals with recycling methods for furniture. The *Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles* stipulates recycling methods for e-waste and the obligations of producers.

Environmental pollutants such as wastewater, noise, and odor emitted from e-waste treatment facilities are subject to the *Water Quality and Aquatic Ecosystem Act*, *Clean Air Act* and *Noise and Vibration Act*. Moreover, these recycling facilities can only be established in certain areas designated by the *National Land Planning and Utilization Act*. Finally, local district ordinances regulate methods of discharge and collection of e-waste and how to impose fines on illegal activities.

The long-term plan for the management of e-waste was included in the *Comprehensive National Solid Waste Management Plan* published in 2012, and the *National Resource Recycling Basic Plan* released in 2011. Additional regulations on collection and recycling methods are highlighted in the *Seoul Waste Management Basic Plan* published in 2012.

The Framework Act on Resources Circulation was first introduced in 2016 and amended in 2018. The pur-

pose of this Act is to outline the basic provisions necessary for "preserving the environment and creating a sustainable resource-circulating society, by reducing the generation of wastes to the maximum extent possible through the efficient use of resources and by decreasing the consumption of natural resources and energy through promoting circular utilization and appropriate treatment of wastes generated" (Ministry of Environment, 2018). The Framework requires the Ministry of Environment to formulate, implement and set standards to accomplish these goals with the support of local governments. They are also required to evaluate standards and strategies every five years and reformulate them every ten years. Moreover, this Act contains specific provisions for waste (including e-waste) management that contains hazardous materials, along with recirculation procedures for such waste (Ministry of Environment, 2018).

Legislation in Korea is continuously revised to reflect the rapidly evolving challenges related to e-waste managment. For example, the *Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles* was revised in 2015 to allow local governments to provide administrative, technical or financial support for business operators and recyclers collecting e-waste. *The Act on Saving and Recycling of Resources* was revised 2017, to regulate a greater number of products and hazardous materials while establishing recycling fees related to these products.

In 2008, Korea introduced the *Act on the Promotion of Saving and Recycling of Resources*, with the purpose of contributing to the "preservation of the environment and sound development of the national economy by facilitating the use of recycled resources by means of controlling the generation of wastes and facilitating recycling" (Ministry of Environment, 2017). This Act has been revised several times since, for example, in 2014 provisions were included for the separate collection of recyclable resources. Similarly, revisions in 2017 allowed the Ministry of Environment (MOE) to impose and collect fees to cover expenses incurred in treating e-waste products that contain harmful substances for the environment or are too cumbersome for recycling by manufacturers (Ministry of Environment, 2017).

The table below outlines major laws and regulations pertaining to e-waste in Korea as of 2014.

Table 9. Laws and Regulations related to E-waste

Items	Laws and regulations
Discharge	-*Waste Management Act* is the main governing piece of legislation -*Act on Saving and Recycling of Resources* sets the separation criteria -*The Framework Act on Resources Circulation* outlines provisions for e-waste recirculation -Local district ordinances and MOE guidelines also support regulation
Collection	-*Waste Management Act* is the main governing piece of legislation -Municipal districts are responsible for collecting solid waste and providing reports on recycling -Transportation and storage regulations are also specified
Treatment	-*Waste Management Act* and the *Act on Saving and Recycling of Resources* sets recycling standards and methods -*Act on Resource of Electrical and Electronic Equipment and Vehicles* is the enforcement mechanism of the *Waste Management Act*; it also mandates recycling obligations of e-waste on producers -*Waste Management Act* covers disposal standards for e-waste; installation and maintenance of recycling facilities; installation, inspection and management standards -*Waste Management Act, Water Quality and Aquatic Ecosystem Act, Clean Air Act* and *Noise and Vibration Act* cover environmental measures for wastewater, noise pollution, odor etc. -*Building Act* covers regulations specific to different types of buildings -*National Land Planning and Utilization Act* determines authorized areas for treatment
Ordinances	-Municipal regulations set out discharge and collection methods along with fines for illegal activities
Policies	-Comprehensive National Solid Waste Management Plan (2012-2021) -Resource Recycling Basic Plan -Eco-Guarantee System -Must provide information on material and structure of products to recyclers -Provide free-of-charge collection service

Source: Yoo Kee-Young, 2014.

8. Comparative Case Study: China

The People's Republic of China (from hereinafter "China") and Korea have similar stringent legal frameworks for e-waste management. However, the two countries differ considerably on collection mechanisms and processing infrastructure allowing for a comparative examination of these two cases. As noted before, Korea generates approximately 0.8 million tonnes of e-waste per year. In comparison, China produces approximately 6 million tonnes of e-waste per year. Additionally, China imports another 1.5-3.3 million tonnes of e-waste annually from other countries (Honda et al., 2016).

8.1 Legal Frameworks

China has ratified both the Basel Convention* and the Ban Amendment**, however, it struggles with huge quantities of e-waste imports. Important laws related to e-waste management in China are:

- *The Law on the Prevention and Control of Environmental Pollution by Solid Wastes* was passed in 1995 and amended in 2005.

- *The Catalogue for managing the import of wastes (MOC, MEP, NDRC, GAC, AQSIQ, 2009, No. 36)* has banned the import of e-waste since 2000.

- *The Technical Policy on Pollution Prevention and Control of WEEE (SEPA No. 115)* came into force in 2006 and sets other "3R" and "Polluter Pays" principles, stipulates eco-design and makes provisions for environmentally sound collection, reuse, recycling and disposal of WEEE.

- *The Ordinance on Management of Prevention and Control of Pollution from Electronic and Information Products*, commonly known as China RoHS (MIIT No.39), has been in force since 2007. It sets requirements for eco-design, restrictions on use of hazardous substances and requirements for producers to provide information about their products.

- Since 2008, the *Administrative Measures on Pollution Prevention of WEEE (SEPA No. 40)* has focused on preventing pollution during disassembly, recycling and disposal of e-waste and has provided a licensing scheme for e-waste recycling companies.

- *Regulations on the Management of the Recovery and Treatment of Waste Electronic and Electrical Products,* commonly known as China WEEE Regulation, was passed in 2009 and came into force in 2011. It makes e-waste recycling mandatory, implements EPR and establishes a fund to subsidize e-waste recycling. The first batch of products covered under this law was limited to TVs, refrigerators, washing machines, air conditioners and computers. In the second batch, this catalogue will be expanded to printers, copiers, mobile phones, water heaters and monitors, among others (Honda et al., 2016).

*Basel Convention, is an international treaty that regulates the trans boundary movements of hazardous wastes and other wastes and obliges its Parties to ensure that such wastes are managed and disposed of in an environmentally sound manner
**The Ban Amendment to Basel Convention prohibits the export of hazardous waste usually from developed countries to developing countries (https://www.unenvironment.org/resources/report/basel-convention-control-transboundary-movements-hazardous-wastes), 2011.

8.2 E-waste Management and Current Challenges in China

Over the past decade, the government of China has proactively worked towards establishing a formal recycling system for e-waste through a variety of environmental laws, standards, and regulations. Progress has been made; however, the government continues to face challenges such as local level implementation of policies, extensive informal networks of waste collectors and private recyclers along with illegal importation of e-waste from other countries.

Despite banning e-waste imports in 2000, China continues to struggle with illegal imports, usually disguised and hidden within legal shipments of other types of allowable waste. The lack of internationally recognized standards on what constitutes reusable electrical and electronic equipment, and what is e-waste amplifies the problem. Imported e-waste remains a major contributor to the informal e-waste networks especially since e-waste entering China from abroad is handled by the informal recycling sector (Ignatuschtschenko, 2017).

China has become increasingly strict on the import of waste; if banned 16 types of solid waste, including plastic in December 2018 and plans to ban an additional 16 types of e-waste by December 2019 (Ministry of Ecology and Environment, 2018). With these stricter controls over imported waste, China aims to reduce the amount of illegal e-waste entering the country since e-waste continues to enter as a part of shipments carrying allowable types of waste. Additionally, local level implementation of e-waste regulations has been an impediment for proper e-waste management in China. This challenge is fueled by inadequate infrastructure for implementation and local economic interests. A ban on informal recycling of e-waste impacts the livelihoods of economically marginalized populations, disincentivizing local governments from completely shutting down these operations.

However, the importation of e-waste and local level policy implementation and enforcement challenges are beyond the scope of this paper as these challenges are not significant factors in the Korean case. This section will focus on challenges related to informal e-waste networks processing domestic e-waste in China. Korea previously faced similar challenges, and a small informal network of e-waste recyclers remains.

Reportedly, the prominence of informal networks in China is embodied by the town of Guiyu in Guangdong province. Guiyu is a major hub, possibly the largest in the world for informal e-waste processing. The unregulated recycling and disposal of e-waste has resulted in environmental degradation, polluted water sources, and toxic fumes in the region. These informal networks usually consist of unaccredited entities that retrieve precious metals from electronic equipment and then dispose of the toxic materials unsustainably, causing severe ground and water pollution. National and provincial governments in China has recently taken steps to establish industrial parks, and improved recycling practices leading to a decrease in pollution levels (Honda et al., 2016).

Furthermore, due to the prevalence of informal collectors and recycling hubs, the government is focusing on policies that incentivize the channelization of e-waste into the formal sector. Accordingly, the formal sector has been equipped with technologically advanced treatment facilities and trained staff. For example, the “Home Appliance Old for New Rebate Program”, which ran from June 2009 to December 2011,

achieved notable success by providing consumers with economic incentives to turn in their household e-waste to formal collectors, who then sold the collected e-waste to designated recyclers for environmentally-responsible processing(Wang et al., 2013). This program incentivized consumers to contact authorized collectors by having them pay higher prices to the consumer for old appliances. The annual formal collection rate under this program reached up to 64 percent. However, since the scheme ended, this number has dropped, and informal collection has once again become more common (Honda et al., 2016).

In 2014, UNDP China in partnership with a web services company, Baidu, launched an app called *Baidu Recycling*. This app allows consumers to easily connect with legally certified e-waste disposal companies for safe disposal and recycling. The *Baidu Recycle 1.0* app recycled eight categories of electronic waste including televisions, washing machines, refrigerators, and digital products, leading to over 4,000 electronic items being recycled in less than a year.

Baidu Recycle 2.0 was released in August 2015 and aimed to make recycling easier and more efficient for customers as well as companies. There were many improvements from the previous version, including, widening product coverage to include small-sized items such as cell phones and laptops. This app also extended coverage beyond original pilot cities of Beijing and Tianjin to 22 cities across China. Furthermore, this app aimed to streamline the recycling process and reduce informal recycling stations ("China: Turning E-Trash into Cash", 2016).

8.3 Comparison with Korea

Despite the various efforts noted above, informal networks of e-waste collectors and recyclers continue to be a serious challenge in China. In contrast, Korea has made the transition from an informal to formal recycling system by creating extensive formal collection networks and by placing greater responsibilities and regulations on manufacturers. For example, the Extended Producer Responsibility system in Korea sets mandatory goals for recycling and penalizes producers who fail to meet their quotas. Furthermore, the Ministry of Environment in Korea provides free collection services for large household appliances.

Korea regulated private recyclers effectively, and those who could not afford to follow the stringent guidelines were pushed out of the market. In China, the formal sector and informal sector are competing for market share. The informal sector usually pays consumers cash for e-waste. Whereas, the formal sector usually pays less or nothing at all, creating significant disincentives for consumers to participate in official collection systems.

The Chinese approach has a focus on consumer behaviour. It encourages consumers to recycle e-waste and provides adequate facilities for e-waste recycling and disposal. For example, the 'old for new' preferential policy aimed to persuade consumers to trade in old appliances for a discount on newer goods and to encourage recycling behavior. Furthermore, in 2012 the government provided subsidies to over 100 accredited dismantling companies to use environmentally friendly technology for the dismantling and processing of the discarded electrical products ("China: Turning E-Trash into Cash", 2016). As of 2016, govern-

ment subsidies are available for safely recycling over 14 categories of e-waste, including items such as smartphones and tablets. In comparison, Korea focused on regulating producer behavior while encouraging recycling among consumers through convenient and inexpensive channels. The Extended Producer Responsibility (EPR) system is a significant part of the Korean e-waste framework, allowing for effective e-waste management. There have been collaborative projects between the Chinese government, Global Environment Facility (GEF), UNDP and private sector stakeholders on the development of an EPR system in China. One project has attempted to utilize internationally benchmarked regulations and technical standards to develop and improve an effective EPR system that can be adapted to the China country context (UNDP China,2018). However, despite these efforts the development of an EPR system in China remains a nascent initiative.

Collaboration between government and manufacturers, includes sharing the financial burden of proper e-waste collection and treatment has proven to be an effective approach for e-waste management. The Korean case highlights the importance of a two-tier approach that targets consumer behaviour but also strongly enforces producer responsibilities. Based on this experience, China may consider increasing producer responsibilities in order to improve e-waste management in the country.

9. Future Outlook and Conclusion

There are various stakeholders involved in the management of e-waste including producers, consumers, private recyclers, governments, and local districts. The recycling of e-waste requires additional treatment that is technically more complex than what is required for residential waste. Not only is the disposal of e-waste more complicated, improper handling can result in injuries and health hazards for e-waste collection crews. Traditionally in Korea, private recyclers were not trained to handle e-waste and often did not comply with recycling methods and facility standards. As a result, Korea's waste management process largely limited the ability of private recyclers and certain businesses to handle e-waste. This understandably has inspired opposition to the system among private recyclers eager to access the market. While the Eco-Guarantee system has been viewed as a success, Korea will need to address the concerns of private recyclers to ensure that the system remains stable. As emphasized previously, producers tend to prefer recycling to disassembly, necessitating a need for the involvement of private recyclers. When private recyclers collect the waste, components can be repaired and sold as second-hand goods. However, with this involvement, government oversight is needed to ensure that private recyclers have the equipment required to recover harmful materials. For example, some private recyclers have been criticized in the past for only salvaging the valuable parts from e-waste, while neglecting heavy metals or refrigerants.

As noted in this policy brief, Korea's systematic e-waste management began with the introduction of a Producer Recycling System based on a deposit-refund scheme.* In 2003, Korea shifted from this framework to the Extended Producer Responsibility (EPR) system which adopted a mandatory recycling rate. When policy

* As highlighted before, the Producer Recycling system obligated producers to deposit an amount based on their production level and allowed them to get the deposit back according to the amount of e-waste they collected and treated.

makers considered making this change, it was expected that producers would react negatively. Instead, the EPR system was well-received by producers since they were able to substantially reduce their costs by constructing their own management system and negotiating recycling goals with the government.

In 2008, Korea's e-waste management framework again changed as the EPR system was phased out in favor of an Eco-Guarantee system, which mandated that manufacturers create environmentally-friendly products. This move was spurred by global trends towards sustainable production and recycling methods that encouraged Korean manufacturers to change their approach. More recently, a new regulation was added to the Eco-Guarantee system in 2014 that set a recycling goal for producers on a kilogram per capita basis. This change highlights the government's reliance on producers as a means of addressing e-waste related problems.

Furthermore, the government has continuously introduced new legislation and updated existing policies to meet challenges related to e-waste. For example, the Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles was revised in 2015 to allow local governments to provide administrative, technical or financial support for business operators and recyclers collecting e-waste.

In closing, the Korean experience demonstrates that proper equipment and training is critical to the reuse and recycling of e-waste materials. While much progress has been made in Korea, better safeguards are needed in specific areas, e.g., to limit the release of greenhouse gas emissions and other toxic materials into the environment. This is particularly relevant if private recyclers are expected to play a more prominent role in the recycling market. Furthermore, Korea has long recognized that a strong relationship with producers is critical in the overall process of e-waste management. Since producers know the structure and materials of their products best, they can strive to make products with environmentally sustainable components and recycle collected electronic waste more effectively. This recognition of the importance of producers can be seen in the creation of the EPR and Eco-Guarantee systems. In the future, Korea's approach to e-waste management will likely continue to evolve as it takes into account changes in technology as well as the evolving demands of consumers and producers.

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