KEPB Issue 2, Volume IX, 2011

Korea Environmental Policy Bulletin

Metal Waste Recycling Plans

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Summary

It is expected that the amount of metal waste generation would be increased over time. Although precious metals and other nonferrous metals retrievable in metal wastes have huge economic value, such precious metals have not been fully recovered or reused appropriately for several reasons such as the designation of few items subject to mandatory recovery and recycling, low level of recovery compared to developed countries, and inadequate technology for recycling. In Korea, metal wastes worth KRW 4.03 trillion are generated every year; the value of metal waste retained countrywide is estimated at approximately KRW 46.4 trillion, and the total economic value would be even higher if all of rare and precious metals discarded amid the continually increasing prices of raw materials and technological advancement are recovered and taken into account. Currently, a total of 10 items such as TV are subject to mandatory recycling under the Extended Producer Responsibility (EPR) system in the category of electric and electronic products discarded at the end of their useful life. The mandatory recycling rate ranges somewhere between

2.4% and 27.4% out of all products released by factory. The recovery rate has been on the increase but it has reached only 43% on the average. Moreover, recovery is carried out separately by different entities. End-of-life vehicles have been recycled in a limited manner because only 3 types of automobiles-sedans, vans, and trucks-are subject to mandatory recycling; large vehicles such as buses and trucks are exempted from mandatory recycling. Only 2 types of wastes generated from businesses, which are byproducts of production process, are being managed.

The recovery and recycling of metals from liquid waste, sludge, dusts, etc. range between 10% and 15%. Under these circumstances, the government established metal waste recycling policies with the goal of saving energy, reducing CO_2, emissions, coping with climate change, and realizing green growth by replacing natural metals with recycled metals while trying to conserve the environment and secure resources at the same time. It seeks to devise measures for stimulating recycling, such as expanding the types of metal waste items subject to mandatory recycling and streamlining the recovery system by establishing and enforcing detailed action plans with regard to the recycling of metal waste.

The government plans to implement measures designed to stimulate the recycling of metal wastes, such as expanding the types of metal waste items subject to mandatory recycling and enhancing the efficiency of the recovery system.

I. Background on the Introduction

Metal waste refers to that generated by households, businesses, etc. and includes metal material. Metal waste recycling means the entire process of collecting, transporting, dismantling, and selecting a variety of metal wastes to condense valuable metals, followed by the melting, smelting, isolating/refining, high value-added process, etc. to convert metal wastes into raw materials for industries.

Metal wastes generated from households include waste electric/electronic products, automobiles, batteries, cans, etc. Meanwhile, metal wastes generated by businesses include the byproducts of production process, such as waste catalysts, waste liquid, sewage sludge generated from the production process, dusts, scraps, slag, etc. and the wastes generated from facilities that are either at the end of their life cycle or have been discarded, such as scrapped ships, trains, aircraft, tools, mechanical facilities, etc.

Mineral resources, specifically rare metal, are concentrated in the top 5 countries including China (90% of the global reserves of rare earth elements and tungsten are concentrated in China), and for their scarcity there would be the risk of depletion. Moreover, their prices have soared amid skyrocketing demand as a result of growth in state-of-the-art industries, such as automotive, semiconductor, communication equipment sectors, etc. along with the increased instability of supply as countries with reserves of these precious resources have used them as weapons by limiting supply, imposing tariffs, and dramatically increasing prices. A great amount of metal is consumed in Korea, but the country lacks

natural resources and imports over 95% of the metals necessary to meet domestic demand and always faces instability in the supply of raw materials to domestic industries. Furthermore, inadequate technology and industrial foundation for recycling have led to the environmental pollution and waste of resources. The amount of metal wastes is continually increasing amid economic growth and increased disposable income and growing consumption of electric and electronic household products.

Metal wastes recoverable from discarded mobile phones, etc. include higher amounts of metals such as gold, silver, copper, tin, etc. than natural ores; over 60%~95% of energy can be saved if they are recycled. In addition, more than 5 types of metals can be recovered from end-of-life vehicles, such as platinum, iron, aluminum, copper, etc. Therefore, the government is making effort to develop metal waste recycling technologies upgraded to the next level such that they are on a par with other developed countries, conserving the environment and securing resources at the same time, and to increase energy-saving by replacing natural metals with recycled metals and cope with climate change and help the nation climb a steeper green growth path by slashing the CO_2 emissions.

Ⅱ. Major Details

1. Act on the Resource Circulation of Electrical and Electronic Equipment

Korea is implementing guidelines for the management of recycling as part of efforts to prospectively enhance recycling and restrict the use of hazardous materials with regard to electric and electronic products and automobiles. However, these guidelines do not specify concrete standards, and they are non-binding recommendations; thus lacking effectiveness. And for the post-consumer stage, the Extended Producer Responsibility (EPR) system is applicable only to electric and electronic products. The management system for the post-consumer stage for automobiles remains inadequate and falls short of international standards. To address these problems, the government enacted the "Act on the Resource Circulation of Electrical and Electronic Equipment" whose purpose is to create resource cyclical systems that preclude the use of hazardous materials and promote the introduction of manufacturing processes that facilitate recycling to stimulate the recycling of electric/electronic products and automobiles, thereby contributing to healthy and sound economic growth and environmental conservation at the same time.

2. Economic Value of Metal Waste

2.1. Quantity of Metal Wastes Generated

Korea has approximately 173 million units of electric/electronic products subject to the Extended Producer Responsibility (EPR) requirements, roughly 35.26 million of which are discarded yearly (Table 1). The country has approximately 16.79 million units of automobiles (based on automobiles registered as of 2008), around 570,000 of which are replaced and scrapped every year (Table 2).

Table 1 : Supply and replacement of electric/electronic products in Korea

(Unit: 1,000 EA)

Type	Total	TV	Refrigerator	Washing machine	Air conditioner	PC	Audio	Mobile phone	Photocopier	Facsimile	Printer
Supplied unit (2008)	173,204	24,637	30,224	16,788	9,084	14,933	3,582	67,032	431	830	5,663
Quantity discarded per year(household)	35,264	3,361	3,930	2,195	1,553	3,790	559	18,275	97	159	1,345
Average life (year)		7.33	7.69	7.65	5.85	3.94	6.41	2.53	4.43	5.23	4.21

Source: data from related government departments (2009), measures for recycling metal wastes

Note: 1) The supplied quantity of TV, refrigerator, washing machine, air conditioner, PC, audio, facsimile, and printer is based on the survey of power consumption trends of households (Korea Power Exchange, 2006) and the supply rate of electronic home appliances.

2) The supplied quantity of mobile phones was estimated based on 46,235 as the number of mobile phone users who signed up for mobile communication service (Korea Communications Commission) and 20,797 units kept at home (purchased but unused) as of late March 2009.

3) The supplied quantity of photocopying machine was estimated based on the EcoAS and useful life (Analysis on the current recycling of waste electric/electronic products and study on the measures to increase the recycling rate, Ministry of Environment, 2009).

4) The average life was cited from the "Analysis on the current recycling of waste electric/electronic products and study on the measures to increase the recycling rate" (Ministry of Environment, 2009).

Table 2 : Quantity of automobiles discarded nationwide

Type	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number of end-of-life vehicles (unit: 1,000 EA)	456	462	463	549	509	516	529	571	655	678
Variation compared to the previous year (unit: 100 EA)	-6	60	14	865	-401	197	-2	419	842	565
The ratio of variation compared to the previous year	-0.1	1.3	0.3	18.7	-7.3	3.9	-0.03	7.9	14.8	8.6

Source: Statistics on end-of-life vehicles, Korea Auto Dismantling Recycling Association (KADRA)

At least 130,777 tons of wastes such as waste catalysts, waste liquid, sewage sludge, scraps, etc. are generated per day by businesses (the quantity of waste generated by households is estimated at 52,072 tons per day as of 2008); this is 2.5 times the quantity of wastes generated by households. Industrial wastes generated by businesses include a variety of metal resources such as rare metal (Tables 3 and 4).

Table 3 : Change in the properties of industrial wastes generated by the facilities of businesses based on year

Type		'03	'04	'05	'06	'07	'08
Total		98,891	105,018	112,419	101,099	114,807	130,777
Combustible	Subtotal	27,950	28,082	30.876	36,076	30,887	29,798
	Waste paper and wood	1,692	1,311	1,941	1,742	2,069	1,901
	Polymer compounds	5,115	5,339	6,451	7,563	6,882	6,766
	Organic sewage sludge	18,369	18,293	19,067	17,115	17,627	17,044
	Others[1]	2,774	3,139	3,417	9,656	4,309	4,087
Incombustible	Subtotal	70,941	76,936	81,543	65,023	83,920	100,979
	Slag	24,166	27,479	29,970	22,801	30,485	32,108
	Fly ash	24,058	20,783	23,080	6,889	10,735	17,679
	metal waste	8,407	3,202	2,940	1,313	1,978	1,691
	Inorganic sewage sludge	10,452	12,565	12,718	16,455	12,882	19,059
	Others[2]	3,858	12,907	12,835	17,565	27,840	30,442

Source: Korea Environment Corporation (KECO) (2009). Generation and processing of wastes nationwide in 2008.
Note: 1) Combustible - Waste debris from plants and animals, waste cooking oils, and other waste of combustible material
2) Incombustible - Waste foundry sand, waste lime and plaster, waste catalyst, waste adsorbents and absorbents, waste glass, waste ceramics, and other waste of incombustible material

Table 4 : Major byproducts generated from the production process in businesses and metals included therein

Type		Major production process generating the waste	Expected quantity of waste generated per year (unit: 1,000 tons)	Metals included therein
Waste catalyst	Petrochemical	Production process for the raw material osf petrol chemical products	0.4	Pt, Pd, etc.
	Refining	Petroleum refining process (De-SOx)	46	Ni, Mo, Co, W, etc.
Waste liquid	Mixed acid wastewater	Manufacturing process for electric/electronic products	89	Au, Pd, Cu, Ni, Sn, Ce, In, etc.
Sewage sludge from the production process	Sludge from silicons that are cut	Production process for semiconductors	2.5	Si, Zn, Al, Cr, etc.
Dusts	Electric arc furnace dust	Electric furnace steelmaking process	400	Zn, Fe, etc.
Scrap	Titanium scrap	Finished product processing	0.36	Ti
	Waste ITO target	Target manufacturing process	0.23	In
	Waste hard metal	Hard metal manufacturing process	0.06	W, Co 등
	Copper	Electric wire and copper/copper alloy manufacturing	120	Cu
Slag	Steel slag	Steelmaking process	8,000	Fe
	Non-ferrous slag	Non-ferrous production process	1,400	Cu, Zn, Pb, etc.

Source: Recycling White Paper *Korea Iron & Steel Association (KOSA), LS-Nikko, Koreazinc Company)

2.2. Economic Value of Metal Waste

The economic value of metal waste retained in Korea is projected at KRW 46.4 trillion, with metal wastes worth KRW 4.03 trillion generated yearly (Table 5).

Table 5 : Economic value of metal waste

(Unit: KRW 100 billion)

Total economic value				Value generated per year			
Total	Electric/Electronic products	Automobile	Businesses	Total	Electric/Electronic products	Automobile	Businesses
464	75	107	282	40.3	13	5.5	21.8

Source: Data from related government departments (2009), Measures for recycling metal wastes
Note: The numbers above were estimated based on the quantities of discarded electronic products and automobiles, which are available from the statistics.

The economic value of all electric/electronic products owned nationwide stands at KRW 7.5 trillion, with metal wastes worth KRW 1.3 trillion generated yearly. Among them, the total economic value of waste electric/electronic products subject to EPR requirements is estimated at KRW 3.4 trillion based on the quantities of units replaced every year (about 36 million units) out of the total quantities of the 10 major electric/electronic products owned nationwide (approximately 170 million units) as of 2008; the electric/electronic products discarded every year are valued at around KRW 540 billion (Table 6.)

Table 6 : Estimated economic value of waste electronic products subject to EPR requirements

(Unit: KRW 100 million)

Type	Total	TV	Refrigerator	Washing machine	Air conditioner	PC	Audio	Mobile phone	Photocopier	Facsimile
Total value (supplied quantity)	34,392	4,372	11,488	9,729	3,242	3,908	133	1,121	116	170
Annual value (discarded quantity)	5,409	596	1,494	1,271	554	995	20	390	27	40

Source: Data from related government departments (2009), Measures for recycling metal wastes

The total economic value of automobiles owned nationwide stands at KRW 10.7 trillion and metal wastes worth approximately KRW 550 billion are generated every year. The total value of industrial wastes retained by businesses across the country is projected at approximately KRW 28.2 trillion, and metal wastes worth approx. KRW 2.2 trillion are generated yearly. This estimate excludes the metals contained in small quantity and whose recovery is difficult because of inadequate technologies for metal recovery and collection. Given the increasing prices of raw materials and advancement of technologies, the economic value of waste electronic products will increase further if rare metals - which are currently scrapped - are recovered fully and taken into account.

3. Items Subject to Recycling and Mandatory Recycling Rate

The Extended Producer Responsibility (EPR) system wherein the manufacturers take responsibility for the recycling of their product when it is no longer useful or discarded imposes a fine on the manufacturer if the manufacturer doesn't perform its responsibility. Currently, EPR is being applied to a total of 24 items.

3.1. Waste Electric/electronic Products

Currently, a total of 10 items are subject to EPR in the category of waste electric/electronic products, such as TV, refrigerator, washing machine, air conditioner, personal computer (PC), audio device, mobile phone, printer, photocopier, and facsimile machine; the total quantity of the aforesaid 10 items is estimated at approximately 173 million units. About 331.3 million units of electric/electronic products can be said to be in use countrywide if the items not subject to EPR are included. The mandatory recycling rate stands at 2.4%~27.4% (based on 2010) of all products released by factory in this category (see Table 7).

Table 7 : Mandatory recycling rate for items subject to EPR

(Unit: %/year)

Item		Long-term recycling goal (2012)	2005	2006	2007	2008	2009	2010
Electronic products	TV	21.0	11.8	12.6	13.3	14.5	16.0	19.0
	Refrigerator	25.0	14.1	16.9	17.3	18.9	20.6	22.1
	Washing machine	30.0	21.2	23.4	24.2	25.3	26.1	27.4
	Air conditioner	2.6	3.6	1.7	1.9	2.1	2.3	2.4
	Personal computer (PC)	14.0	8.5	9.4	9.8	10.3	11.1	12.3
	Audio	20.0	10.2	12.7	13.1	14.9	15.5	17.0
	Mobile phone	25.0	11.9	15.4	16.5	18.0	19.8	22.0
	Printer	15.0	-	8.4	9.2	11.2	11.9	13.0
	Photocopier	15.0	-	8.4	9.4	12.7	13.3	14.2
	Facsimile	15.0	-	8.4	9.4	11.4	12.1	13.4

Source: Ministry of Environment Notice No. 2006 - 219, Ministry of Environment Notice No. 2009 - 283, website of the Ministry of Environment

3.2. End-of-life Vehicles

Only 3 types of automobiles - sedans, vans (with carrying capacity of 9 persons or less), and trucks (light, small trucks with gross vehicle mass of 3.5 tons or less) - are subject to EPR. The mandatory recycling rate for these types of automobiles out of the total end-of-life vehicles (905,000 tons) reaches 83.4% (755,000 tons, as of 2008). Large buses and trucks have been recycled in a limited manner because they are not subject to EPR requirements. In addition, waste gases, spent fuels, etc. generated from large buses and trucks have been managed inadequately. Current options for most non-ferrous metals excluding valuable metals are landfills and incineration; non-ferrous metals making up 27.2% of all components used in automobiles need to be recycled more actively.

In this situation, the government plans to increase the combined rate of recycling and energy recovery to 85% based on the weight of the recovery per a end - of - life vehicle by 2014 and increase the rate to over 95%, which is the mandatory recycling rate, beginning 2015.

3.3. Industrial Waste

Industrial wastes have not been managed and recycled systematically because only 2 types of byproducts (steel slag and coal material) as the secondary or incidental products derived from the production process have been managed as designated byproducts; the remaining byproducts and wastes generated during the shutdown of business are excluded. The target recycling rate for steel slag and coal material is set at 95% and 70%, respectively.

4. Collection of Metal Waste and Recycling Technology

4.1. Collection

- Waste Electric/electronic Products

Electric/Electronic products discarded countrywide have been managed and operated through the EPR system (Environment - Friendliness Guarantee System after 2008) that went into effect in 2003, and about 100 manufacturers have implemented their recycling obligation through the Recycling Business Mutual Aid Association ("Korea Association of Electronics Environment").

A total of 118,800 tons of electric/electronic products subject to EPR have been collected thus far, with the distributors collecting 74% (88,000 tons), recycling firms 16% (18,000 tons), and local governments 10% (12,000 tons). The collection has increased since the introduction of the EPR system (by an annual average of 27%) but remains 43% on the average. In 2008, manufacturers collected 83,558 tons of waste electric/electronic products per day, mostly through their distribution centers; this is the largest quantity followed by local governments and recycling firms, which collected 23,449 tons/year (18%) and 23,415 tons/year (18%), respectively (Table 8).

Table 8 : Quantity and ratio of waste electric/electronic products collected (as of 2008, based on weight)

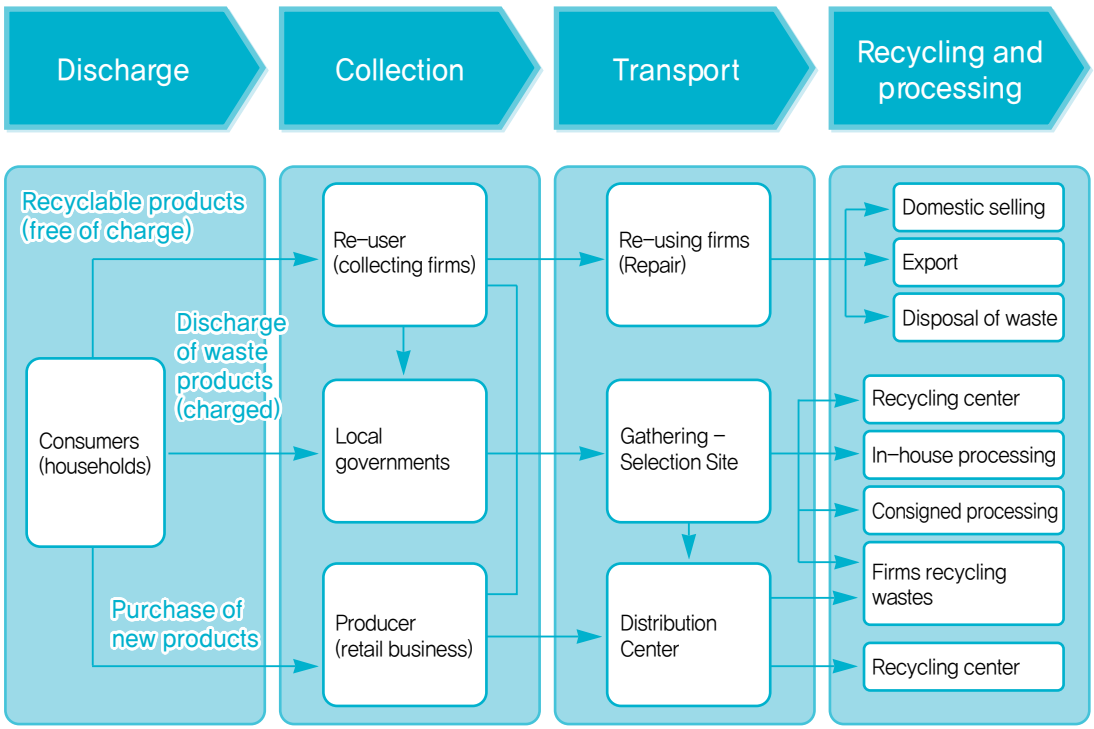
(Unit: ton/year)

Type	Local governments (a)	Retail business (b)	Recycling business (c)	Total (d=a+b+c)
Refrigerator	18,473	40,441	1,412	60,326
Washing machine	569	21,129	1,774	23,472
Air conditioner	16	3,636	100	3,752
TV	4,107	15,959	4,488	24,554
Computer	44	439	3,352	3,835
Monitor	104	79	9,117	9,300
Audio	81	454	703	1,238
Mobile phone	0.4	322.3	340	662.7
Printer	32	613	1,497	2,142
Photocopier	21	438	557	1,016
Facsimile	2	48	75	125
Total	23,449.4 (18.0%)	83,558.3 (64%)	23,415 (18%)	130,422.7 (100%)

Source: Internal data of Korea Environment Corporation (KECO) (September 2009)

The collection, however, is carried out separately by different entities, i.e., local governments, manufacturers, and individual collectors. Costs incurred for the mandatory transport of collected products not subject to EPR, coupled with the excessive costs of transportation (which is 2~3 times higher compared to ordinary transportation fee), put extra strain on the finances of recycling firms.

Figure 1: Process of collecting and recycling waste electric and electronic products



Source: Ministry of Environment (2009), Measures for recycling metal wastes

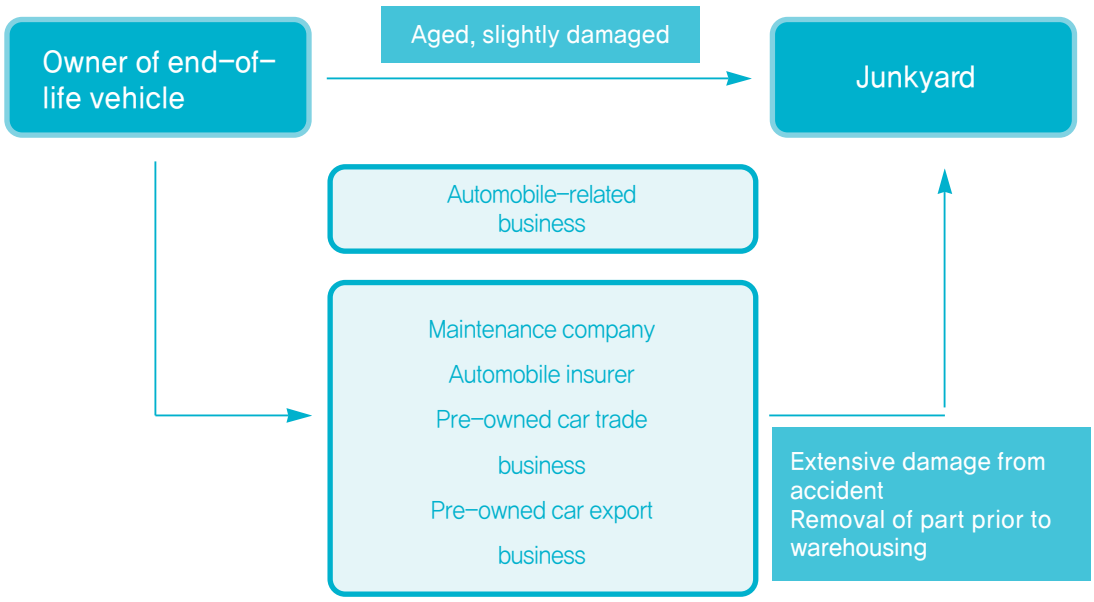
- End-of-life Vehicles

The mandatory recycling rate for end-of-life vehicles is 83.4% (755,000 tons, as of 2008) of all end - of - life vehicles (905,000 tons). End-of-life vehicles are recovered in around 430 junkyards across the country. In 2008, the mandatory recycling rate for automobiles was 75.6%. At least 480,000 units weighing a total of 552,000 tons were dismantled, 417,000 tons of which were recycled; usable automotive parts were reused, and scraps have been recycled effectively.

The recovery of end - of - life vehicles is sometimes directly commissioned by the final owner to the junkyard (where the dismantling takes place) or companies specializing in automobiles. Nowadays, companies receive orders online for the dismantling of automobiles.[3)]

3) Ministry of Environment (2010), "A study on the measures to improve the recycling system for electric/electronic products and automobiles"

Figure 2: Process of collecting end-of-life vehicles



Source: Ulsan Regional Environmental Technology Development Center (UETC) (2008), "Analysis on the pollution loads of discharged pollutants in the total recycling process of end-of-life vehicles in the Ulsan region"

- Industrial Wastes

Except industrial wastes collected and recycled by waste management companies or recycling firms, other industrial wastes are buried in landfill or incinerated. Over 80% of scraps and non-ferrous scraps have been used thus far, but the recovery of metals from waste liquid, sludge, dust, etc. and their recycling range somewhere between 10% and 15%. Currently, only 2 types of byproducts - steel slag and coal material - are designated for mandatory recycling; this suggests that very few items have been subject to mandatory recycling, and the recycling target rate for coal materials is as low as 70%.

4.2. Level of Recycling Technology

The level of technology in Korea for recovering precious metals, etc. from scraps, has reached 80% of that of developed countries. However, the level of technology in Korea for recovering precious metals from waste products and recycling them has reached only 20%~50% of that of developed countries. In particular, the level of technology in Korea for the validation, commercialization, and high - purity processing has reached only 20% of that of developed countries except high - priced metals (7 metals such as platinum, indium, etc.) with regard to rare metals. As a result, primary processed products (low grade) have been exported to developed countries and subsequently re-imported as industrial raw materials (high grade). Thus, government departments are pushing ahead with efforts to upgrade recycling technologies given the pressing need to secure global standard metal waste recycling technologies (basic, validation, commercialization, high - purity processing, and replacement). Specifically, the Ministry of Environment contracted out a project that aims to establish mid - and long - term plans for recycling metal wastes, with the Ministry of Knowledge Economy pursuing

the development of technologies for recovering metal resources, technologies for reducing their consumption, and technologies for substitution. The government plans to invest in the development of technologies by sector and operate support centers while going ahead with the systematic development of technologies based on the roadmap for developing metal waste recycling technologies and expanding the necessary support. Additionally, the government will strive to make sure that the level of technology in Korea reaches 70% of that of developed countries by 2013 and 90% to 110% of that of developed countries by 2020.

Table 9 : Type of metals and level of technology in Korea by sector compared to developed countries

Type of metal	Sector	Basic technology	Validation technology	Commercialization technology	High-purity processing technology	Substitution technology
Precious metal (gold, silver)	Scrap	80~90%	70~80%	70~80%	40~50%	30~40%
	Waste products	40~50%	40~50%	40~50%	40~50%	20~30%
Non-ferrous metal (copper, tin, etc.)	Scrap	80~90%	70~80%	70~80%	60~70%	40~50%
	Waste products	50%	40~50%	40~50%	30~40%	30~40%
Rare metal (indium, etc.)	Scrap	50%	50~60%	30~50%	20~30%	30~40%
	Waste products	30~40%	30~40%	20~30%	20~30%	20~30%

Source: Korea Institute of Geoscience and Mineral Resources (KIGAM)

4.3. Current Technologies for Recycling Waste Electronic Products

The technology for recovering and recycling waste PCBs from waste electric/electronic products, such as discarded computers and mobile phones, can be divided into the pyrometallurgical process and the technology that combines the process of mechanical pre-treatment and hydrometallurgical processes.

- Commercialization of Technology Using the Pyrometallurgical Process

The vigorous commercialization of technologies that apply the pyrometallurgical process is the key driver stimulating the recycling of waste electric/electronic products countrywide. For that, it is essential to ensure the uninterrupted supply of waste electric/electronic products to companies that have succeeded in commercialization. Such steady flow of supply will be assured only when these manufacturers that succeeded in commercialization are given priority in receiving the supply of waste electric/electronic products. The pyrometallurgical process offers many advantages but also has the disadvantage of low recovery rate of precious metals (such as gold, silver), copper, and valuable metals such as tin, nickel, zinc, etc.; hence the need to develop technologies steadily to overcome such shortcomings.

- Developing the Technology Combining the Process of Mechanical Pre-treatment and Hydrometallurgical Processes

Waste scraps from various waste electronic devices across the country include valuable metals such as copper, iron, nickel, zinc, etc. as well as precious metals such as gold, silver, palladium, etc. The technology combining the process of mechanical pre-treatment and hydrometallurgical processes is as follows.

(1) Development of dismantling process: Given the vast array of waste electric/electronic products, which makes it difficult to install a coherent automated process, there is a need to dismantle the products manually instead of relying on mechanical dismantling. The most typical examples are photocopiers, audio devices, laser/ink jet printers, and LCD monitors. In the process of dismantling, the dissembling time is an important factor.

(2) Development of pre-treatment foundation technology: Since waste PCBs include various valuable metals, there is a need for pre-treatment foundation technology that involves the processes of breaking up, pulverizing, and selecting to condense and recover these valuable metals.

(3) Development of leaching technology: The selection of leaching agents is involved, and the development of leaching technology is required to extract valuable metals effectively from the condensed metals obtained through the pre-treatment process of waste electric/electronic products. Electrolytic leaching as the next-generation leaching technology, acid leaching using hydrochloric acid/sulfuric acid/nitric acid, and microbial leaching need to be developed.

(4) Development of isolation and refining technology: Recovering valuable metals from waste electric/electronic products requires developing technology for leaching the condensed metal, using nitric acid, obtained from the process of breaking up, pulverizing, and selecting waste PCBs, followed by solvent extraction, isolation subsequent refining using supported liquid membrane.

4.4. Current Recycling Technologies for Recycling End-of-life Vehicles by Material

Based on the current recycling status of automobiles nationwide, raising the recycling rate for automobiles to 85% by December 31, 2014 does not seem difficult. Once the goal is achieved, efforts must be made from January 1, 2015 to increase the recycling rate further by 10% to reach the recycling rate of 95%.

Thus, in Korea, extensive efforts must be made to reach the target recycling rate by developing the technology for dismantling all parts of cars that can be taken apart, along with the technology for managing the materials whose recycling is difficult while stimulating the use of pre-owned parts. Currently, domestic manufacturers are pushing ahead with R&D and development of technologies to increase the recycling of hardly recyclable byproducts (fractured debris, air bag, waste gas, and glass) of end - o f- life vehicles; little progress has been made, however. Therefore, plans have been established to set and manage the annual recycling target for the 4 materials known to be difficult to recycle as well as the overall recycling target specified by the current Resources Recycling Act.

The current domestic recycling technologies by item are as follows:

(1) The fabrics of air bag are made up of nylon, which inflates after an impact. Domestic manufacturers have been collecting some of those fabrics and developing technology to recycle them into automotive parts.

(2) As for waste gases (waste refrigerants),

technologies have been developed to recycle high-purity refrigerants among the recovered refrigerants into reusable refrigerants and incinerate low - purity refrigerants.

(3) Some domestic manufacturers have successfully completed R&D projects for automobile shredder residue (ASR) gas melting furnace utilization in collaboration with domestic smelting and refining companies to recycle ASR. The thermal recycling technology is to be commercialized.

(4) Technologies have been developed to recycle glass into construction materials, but the technologies has not been commercialized.

Ⅲ. Future Plans

1. Expansion of Metal Waste Items Subject to Mandatory Recycling

1.1. Metal Wastes Generated by Households

Korea has far less number of items subject to EPR than developed countries and sets an even lower mandatory recycling target; hence the need to specify the methods and standards for new items that will be added to EPR. A plan to introduce the "recycling target management system" has been established in Korea, switching to the EU system that requires manufacturers to collect 4kg of electrical waste per inhabitants in a bid to increase the mandatory recycling rate for all electronic wastes.

Meanwhile, no institutional system has been put in place for managing end-of-life vehicles other than those subject to mandatory recycling. Furthermore, non-ferrous metal recycling has been insufficient. Therefore, a measure has been considered wherein the types of end - of - life vehicles subject to mandatory recycling would be gradually expanded from the current 3 types - sedans, vans with carrying capacity of 9 persons or less, and trucks with gross vehicle mass of 3.5 tons - to cover all types of sedans, vans, and aforesaid trucks, and ultimately, all types of motor vehicles. To achieve the mandatory recycling target (over 85% before 2014, over 95% after 2015), a shift will be made to the Extended Producer Responsibility (EPR), an environmental policy approach wherein the responsibility of a producer (manufacturer, importer) is fully extended to the recycling of a vehicle after its life cycle instead of passing the responsibility implicitly onto recycling firms as is currently the case.

In meeting the recycling target, strategic metals such as steel, precious metals, and ordinary non - ferrous metals will be recovered 90% by 2013, and rare metals up to 70%~80% by 2020.

1.2. Byproducts Derived from the Production Process

Petrochemical waste catalysts that are highly prized for industrial purposes - will be managed as designated byproducts by revising "Enforcement Decree of the Act on the Promotion of Saving and Recycling of Resources" by this law and the types of designated byproducts currently limited to the categories of steel slag and coal material. In addition, surveys will be conducted to keep abreast of the trends and conditions of wastes generated by firms at the end of the life cycle such as scrapped ships and waste tools, etc. and measures will be taken to promote recycling.

2. Streamlining the System for Collecting Metal Wastes

2.1. Establishment of a System for Collection Available Whenever Necessary

The fee for the disposal of large electric home appliances needs to be adjusted to a reasonable level in sync with reality; small electric and electronic products and metals have not been managed systematically because of the absence of guidelines for separate garbage collection. Thus, a measure has been considered wherein the fee for the disposal of large electric home appliances as imposed by local governments is removed and a system for separating recyclable, small home appliances is introduced. Moreover, a system will be put in place to ensure the collection of metal wastes is available whenever necessary, such as strengthening the obligation of manufacturers to collect recyclable items and making the retail businesses pull their weights in recycling. To collect and recycle waste batteries, a collection system will be put in place at the major sources of waste generation such as households, large companies, military camps, etc. Collection campaigns will also be launched regularly.

2.2. Pan-national Campaign to Collect Metal Wastes

Compared to the amount of waste mobile phone generation, manufacturers' mandatory recycling rate still remains low(19.8%); hence the inadequate waste mobile phone recycling. Meanwhile, most people keep the waste batteries at home because they do not know how to dispose of them. In response to that, a measure has been considered wherein campaigns for collecting metal wastes (waste mobile phones, waste batteries, etc.) are launched regularly and the "Day for Collecting Hidden Resources" is designated as part of the nationwide endeavor to increase the collection of metal wastes. Moreover, waste battery collection campaigns will be carried out constantly in collaboration with private-sector businesses to promote the collection of waste batteries and raise awareness of recycling.

2.3. Improving the System for Transporting Metal Wastes

Currently, there is a lack of cooperation between manufacturers and local governments with regard to the collection of waste electric home appliances, and the cost incurred in the transport of the collected waste products accounts for a major proportion of recycling costs. Therefore, there is a need to improve the system for collecting and transporting waste electric home appliances. In addition, the waste products and wastes generated by businesses - except items subject to EPR - can be transported only via the vehicles given the import/transportation license; thus putting extra strain on the finances of recycling firms. The designated storage period (30 days, up to 60 days) and storage capacity (30 days) serve as stumbling blocks for recycling companies that attempt to devise long - term plans. Therefore, the standards for transport and storage need to be adjusted at a reasonable level. As such, a measure has been considered wherein an improved collection/transport system covering the metropolitan area is introduced, a system of stocking products by region is built, ordinary vehicles are allowed to be used for collecting and transporting metal wastes that pose minimal hazards to the environment, a reporting system is adopted to stimulate the metal waste collection and transport business, and the storage period is extended from the current 30 days to 90 days.

Published by

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ISSN 1976-6246

9 771976 624002 92