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Introduction of a Home Appliance Recycling System:
Effects & Prospects:
Progress towards Utilisation of Recycling Infrastructure

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Economic and Industrial Research Department
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Contents

Introduction of a Home Appliance Recycling System: Effects & Prospects: Progress towards Utilisation of Recycling Infrastructure

Summary

1. Enacted in April 2001, the Law for Recycling of Specified Home Appliances (Home Appliance Recycling Law) has been introduced as part of a raft of legislation aimed at building up a society based on re-use of resources, in order to promote the recycling of used consumer electric appliances, which up till now have been disposed of as normal household waste. Two supplementary laws support this law, the Waste Disposal Law promoting the appropriate disposal of waste, and the Law for Promotion of Efficient Utilisation of Resources aimed at achieving efficient use of resources. These laws prepare the ground for an original scheme based on division of responsibilities among the parties involved, in the setting up of Japan's first full-scale, private sector-based post-consumer waste (PCW) recycling system. This report will consider the challenges faced in achieving efficient operation of this system, which will have great significance for the construction of a larger-scale recycling system handling used autos and other products, as is expected to follow.

2. The waste volume of the four specified categories of home appliances (refrigerators, washing machines, televisions and air-conditioners) to be handled by the new system that the Home Appliance Recycling Law will introduce, at an annual expected weight of 600,000-700,000 metric tons, is only equivalent to 1% or less of the total weight of household waste. By unit volume, around 20 million units in these four categories are expected annually. Even assuming none of the previous exportation of used goods or disposal by local authorities takes place, and that the full volume enters the new recycling system, then the annual market scale of collection and recycling of these four categories will only be in the region of ¥100 billion. Adding on all other categories of consumer electric and electronic appliances such as personal computers and mobile telephones, the annual recycling market scale would be around ¥300 billion. Therefore, although the social significance for Japan of setting up the foundations for a full-scale PCW recycling system is great, the scale of the market created will be small.

3. In order to examine the profitability of the home appliance recycling scheme, we have assumed a fixed number of collection centres (designated exchanges) and their accompanying recycling plants (processing capacity of 600,000 units per year). Although the recycling yield rate will be influential, we estimate that the break-even point will be reached if 50-60% of plant processing capacity in home appliances is collected.

However, there are a number of indeterminate factors affecting the collection volume of used home appliances, such as exportation of used goods and unlawful disposal. Achieving a profitable collection rate (= plant operating rate) even in urban areas does not look easy, let alone on a national scale.

4. The manufacturers, who must ensure the recycling of waste under the new recycling system, are already responding in a variety of ways to avoid damaging their business profitability. In order to keep expenses down to the minimum, corporations are following one of two models: 1) using

existing waste processors' infrastructure in order to reduce total costs (dispersed model); or 2) installing new processing facilities integrated with an efficient logistics system in order to reduce total costs (centralised model). Both models have their respective strengths and weaknesses, and until they are actually in operation it will be difficult to assess their true merits.

Although home appliance recycling will have a relatively small market scale, and is faced by the economic problems already mentioned, it is expected to bring great social benefits. Existing methods such as landfill disposal of appliances in their original form have caused problems including the release of harmful substances into the environment (for example, soil pollution by heavy metals) arising from insufficient pre-disposal processing, and an acute shortage of waste-disposal space. Home appliance recycling is both a form of environmental business, and also a social infrastructure business arising out of the extension of the responsibilities of manufacturers of home appliances and other goods. However, the significance of the latter is probably greater.

5. Outside of Japan, attempts to set up recycling systems for used home appliances and other goods are also under way. In June 2000 the European Commission announced their Proposal for a Directive on Waste Electrical and Electronic Equipment (WEEE). Henceforth, EU member states are expected to enact strict domestic laws covering a wide range of targeted appliances, and including bans on the use of harmful substances.

Germany in particular has adopted advanced waste disposal policies since the late 1980s, and is currently considering regulation covering home appliances. Under the Cyclical Economy and Waste Law, no improvement has been seen in exportation of WEEE, or its incineration or landfill disposal mixed together with household waste. Many details are unclear, but collection is organised through regular local government bodies, in direct contrast to waste packaging materials. Furthermore, even in Germany where a wide range of appliances are targeted, the scale of this market is only estimated at around ¥100 billion (disposal costs), accounting for a limited portion of the overall waste disposal industry.

6. Home appliance recycling in Japan faces a number of challenges at its inception as the nation's first PCW recycling system led by the private sector. Revisions are planned depending on how the system progresses, and a number of controversial points suggest themselves regarding stable operation of recycling facilities and achievement of industry profitability.

Firstly, in order that as many home appliances as possible covered by the system actually enter it, the charges levied on the discarder will need to be reduced. To achieve this, development of technology aimed at reducing the prime cost of processing must be promoted, and costs arising from the system's design reduced. By costs arising from the system's design, we mean regulatory costs such as of obtaining licences, stemming from the legal definition of used home appliances as waste. The definition of waste in the Japanese legal system will probably have to be revised.

Secondly, when considering future revisions to re-commercialisation rates, currently-rejected reverse-payment arrangements will become a problem. Processing of waste plastic is a particular challenge to be overcome in order to raise re-commercialisation rates, and parallel introduction of a 'recycling rate' that can incorporate reverse-payment arrangements will likely come under consideration. This would enable targeting of new processing methods such as conversion into blast-furnace raw materials, which would boost the prospects of recycling products with high plastic-composition weightings. Other benefits of this would include making possible comparison with European and other leading standards.

Thirdly, when considering expansion of the targeted appliance range, in addition to home appliances not currently included in the four categories, a common processing infrastructure

encompassing also IT equipment should be examined. The question of IT equipment such as mobile telephones and personal computers is currently being examined under the Law for Promotion of Efficient Utilisation of Resources. Separate schemes divided by equipment category will lead to problems such as some types of equipment not being recycled at all, difficulty of maintaining appropriate operating rates at processing plants due to insufficient processing volume, and could well actually increase overall costs.

It is hoped that the problems revealed by such considerations can be overcome, to achieve optimum performance from recycling infrastructure established according to the Home Appliance Recycling Law, and so it can develop to handle all common forms of PCW.

Foreword

At the dawn of the 21st Century, the legal system covering waste processing and recycling is undergoing major changes, aimed at the establishment of a cyclical social system. Following heated debate both in Japan and overseas on the recycling of waste products, Japan saw the full enactment of the Container and Packaging Recycling Law in 2000, and enactment of the Law for Recycling of Specified Home Appliances (Home Appliance Recycling Law) in April 2001. Furthermore, the debate over a recycling system targeted at many products including personal computers and rechargeable batteries has developed rapidly, based on the Law for Promotion of Efficient Utilisation of Resources.

This report examines the full-scale private-sector recycling system for waste products being introduced by the Home Appliance Recycling Law, and considers future developments.

Chapter 1 provides an outline of the legal system relevant to this field, and examines recycling schemes based on extended producer responsibility (EPR). Chapter 2 considers the role, the economics, and the characteristics of home appliance recycling within the developing recycling industry as a whole. Chapter 3 takes a look at the situation overseas, by providing an outline of the EU's WEEE Directive Proposal on waste electric and electronic equipment, and the continuing debate in Germany. Chapter 4 summarises areas of contention for future revisions of Japan's home appliance recycling system, including overseas trends, largely from the viewpoint of stable operation of facilities and achievement of business profitability.

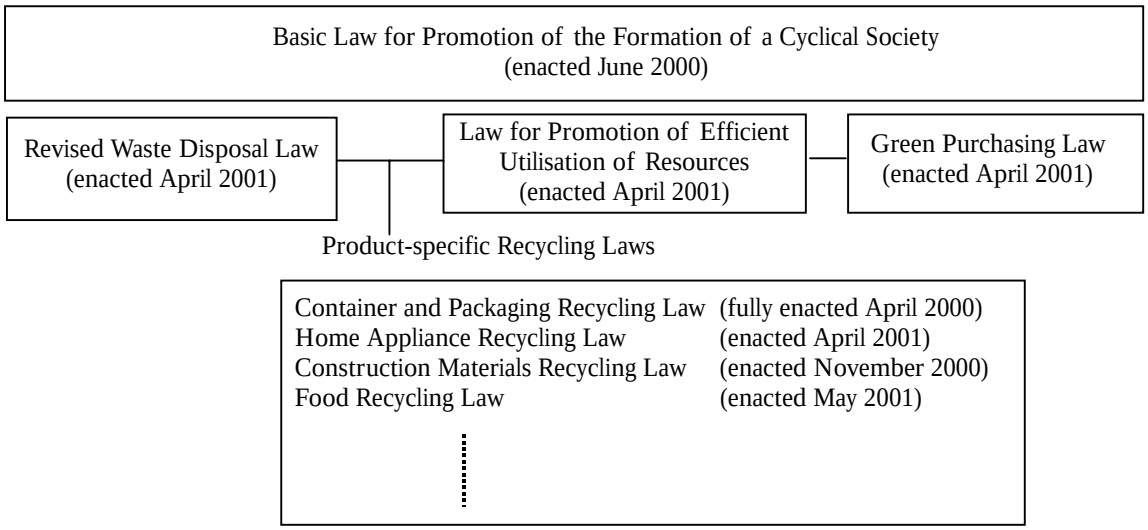
I. Outline of the Legal System Covering Recycling of Home Appliances

1. Introduction

It has long been pointed out that in the 21st Century Japan needs to replace its heavy dependence on non-renewable natural resources, and generation of large volumes of waste for which there is no space, with a society based on re-use of resources. Accordingly, in the last few years of the 20th Century Japan passed a succession of new laws or law revisions concerning waste and recycling. Many of these new laws came into force on April 1st, 2001. Japan's new waste policy will be based on the framework of the Basic Law for Promotion of the Formation of a Cyclical Society, enacted in May 2000, with the greatly revised Waste Disposal Law and Law for Promotion of Efficient Utilisation of Resources, which are general laws covering waste processing, recycling, and re-utilisation. The new set-up for the 21st Century is completed by recycling laws specific to individual product categories, and the Green Purchasing Law, aimed at creating and consolidating markets for environmentally-friendly products including those resulting from recycling (see Figure 1-1). There are four product-specific recycling laws, covering containers and packaging, home appliances, construction materials, and food. The containers and packaging recycling law was the first to be enacted.

This report will focus on the Home Appliance Recycling Law, and examine the problems that must be overcome if the scheme is to work well.

Figure 1-1. Japanese Waste Disposal Legislation



Source: Prepared by DBJ.

2. Used Products and Recycling Problems

The Law for Recycling of Specified Home Appliances (henceforth 'Home Appliance Recycling Law') stands alongside the Container and Packaging Recycling Law which was fully enacted in April 2000 in systemising the recycling of waste products. Waste problems are the source of much debate, but the focus of discussions on household waste both in Japan and overseas is schemes to regulate PCW (post-consumer waste). PCW is waste from products which for a time have been the property of consumers. Under the traditional polluter pays principle (PPP) of environmental policy, the polluter (discarder) is therefore the consumer. However, the aim of the policy is to restrict generation of waste, and promote recycling of unavoidable waste, so its initial objectives will not be achieved if regulation results in the stock of goods, which for consumers no longer have any usage or exchange value, simply increasing. As a result, the problems of defining the 'discarder' of products that have been the property of consumers need to be resolved, and this has attracted much debate.[1]

One solution to this problem is known as extended producer responsibility (EPR), whereby responsibility of the discarder is traced back beyond the consumer and extended to the parties involved in production, processing and sales. Construction of PCW recycling schemes through introduction of the EPR concept was pioneered by Germany with its Packaging Materials Ordinance (Verpackungsverordnung, 1991) as discussed in Chapter 3, and has since become a major trend in Europe. The introduction of this concept to Japan took place only recently through the passing of the Basic Law for Promotion of the Formation of a Cyclical Society in 2000.

Of course, the application of EPR is not uniform. In the case of Germany, as described later consumers pay a volume-based commission for disposal of household waste. Therefore transferring responsibility for collection and re-cycling of packaging materials to the manufacturers and others created a new free disposal system for consumers (to be strict, payment is included in the purchase price of the goods). This generates strong economic incentives for consumers to sort waste, and Germany has been notably successful in channelling such waste into recycling routes. This system does not apply to all categories of waste, and some recycling schemes divide responsibility between local authorities and manufacturers, for example, batteries and WEEE (under consideration). Schemes are thus tailored to the characteristics of the targeted waste goods.

In the case of Japan, household waste is in principle disposed of by the local authorities. The introduction of EPR to tackle the problems of PCW, in addition to this base of public services funded by tax, will differ from the German example noted above. In fact, the major role played by local authorities in the Japanese containers and packaging recycling scheme, and the limited role to be played by local authorities in home appliance recycling, are exactly opposite to the German model. In Japan, processing of household waste is largely publicly funded, consumption being characterised as fundamentally non-exclusive and non-competitive. Japan's legal system does not exclude the possibility of levying of commissions and private-sector sub-contracting, but this plays a minor role. Up to now it has been normal practice to levy disposal commissions on home appliances, which are classified as 'large waste'. Although the commissions charged do not necessarily reflect the actual disposal cost[2], the charging of even part of the prime cost creates exclusivity, diluting the disposal system's qualifications as a public service. Containers and

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1 Please refer to Sano, Shichida [2000] for more on international development of EPR.

2 According to estimates from the Home Appliance Recycling Research Group Report issued by the Tokyo Metropolitan Government's Cleaning Department, the average unit disposal cost of home appliances is ¥8,733 for air conditioners, ¥6,177 for televisions, ¥12,780 for refrigerators (not including the cost of collection and breaking down of coolant CFCs), and ¥7,688 for washing machines. These costs are all several times the large waste disposal commissions charged.

packaging were in principle treated as household waste until the introduction of the recycling law. Japanese divergences from the German model are likely to have influenced the form of EPR adopted.

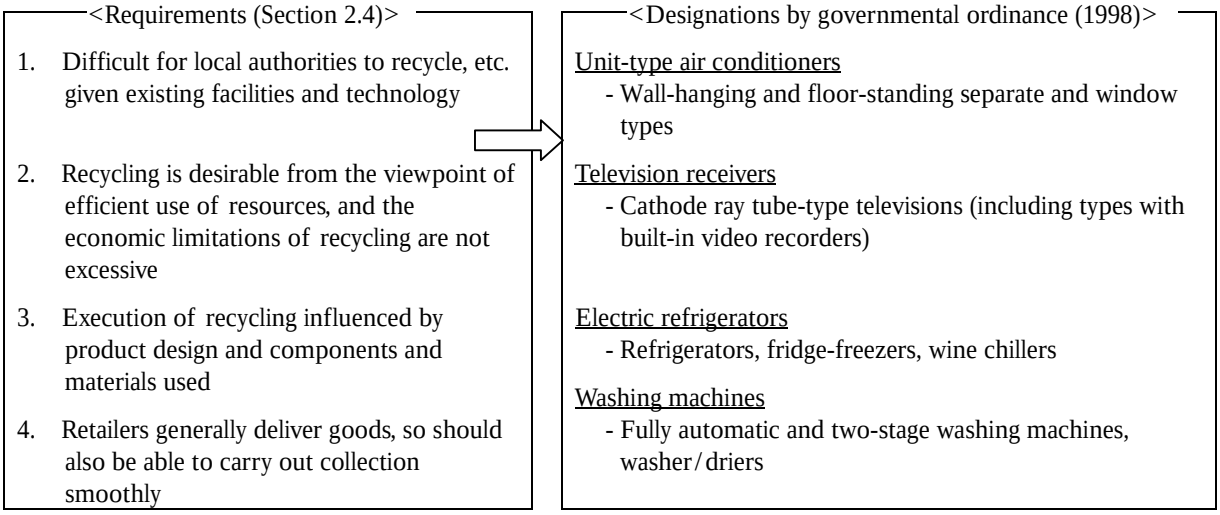
In any case, the Home Appliance Recycling Law is a revolutionary development in Japanese waste disposal, introducing as it does genuine PCW recycling based on the EPR concept.

3. Highlights and Characteristics of the Home Appliance Recycling Law

3.1 Outline of the New System

The Home Appliance Recycling Law sets up measures for the appropriate and smooth execution of collection, transportation, and recycling by retailers and manufacturers, with the aim of appropriate disposal of waste and the efficient use of recycled resources recovered from home appliances (Home Appliance Recycling Law, Section 1). The special Waste Disposal Law defines the appropriate disposal of waste, and the special Law for Promotion of Efficient Utilisation of Resources defines efficient use of resources. The targets of the law are legally defined as 'specified home appliances', with their categories to be designated by government ordinance. The designated four categories of appliances were defined in the Law for Recycling of Specified Home Appliances Enactment Ordinance, as set out in Figure 1-2. The first requirement of specified home appliances is that they are difficult for local authorities to recycle given existing facilities and technology. This is based on the proclamation (March 1994) of the Waste Disposal Law, Special Law Section 6.3, and is direct evidence that the Home Appliance Recycling Law is a special law relating to the Waste Disposal Law, further defining the appropriate disposal of difficult items[3].

Figure 1-2. Specified Home Appliances

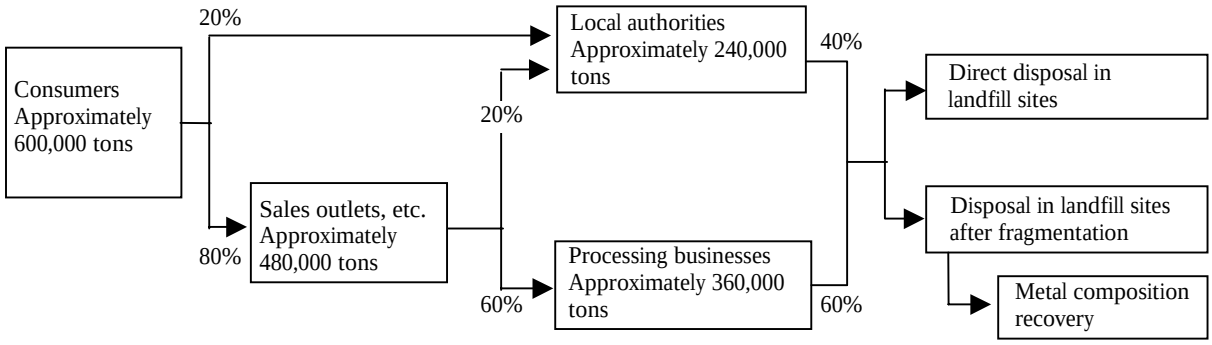


Source: Prepared by DBJ.

[3] The designated targets of measures covering household waste items that are difficult for local authorities to recycle given existing facilities and technology, include some large-scale home appliances (television receivers with screens of 25 inches or more, refrigerators with capacity of 250 litres or more), waste tyres, and sprung beds. Parties responsible for the production, selling and such of these items can be requested to provide assistance. As pointed out by Sano [2000], the fact that makers and sellers of these items have been brought into the public service of household waste disposal, is noteworthy as an early example of EPR in Japan.

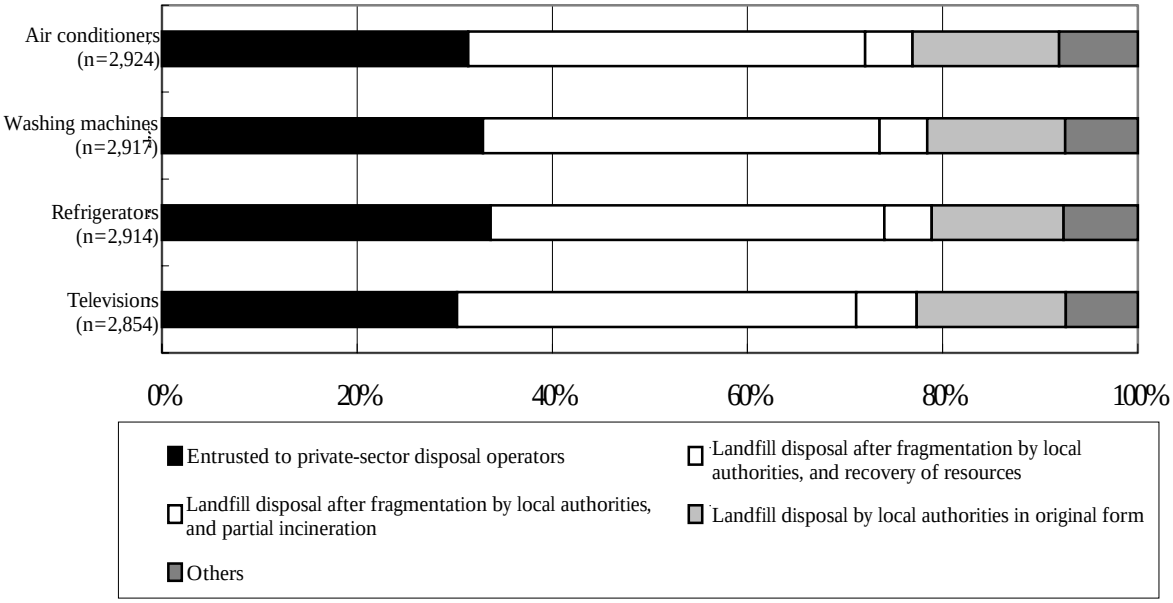
In fact, it appears that it would be extremely difficult for local authorities to dispose appropriately of the four categories of used home appliances. Figure 1-3 is a flow chart showing how the disposal of the four categories has been carried out up to now. The flow illustrated represents urban areas, and the disposal weighting borne by regional local authorities is thought to be higher, but it is clear that local authorities dispose of at least 40% of total waste volume. Figure 1-4 shows disposal methods, with direct landfill disposal of items in their original form accounting for around 15%, and a significant volume being entrusted to the private sector for disposal. This illustrates the limits of disposal by local authorities on their own. Local authorities are ill-equipped for efficient recovery of resources from home appliances, and there are concerns over the large social costs resulting from leaching of harmful substances from landfill sites, and other problems.

Figure 1-3. Disposal Flow for Four Categories of Used Home Appliances



Source: Ministry of Health, Labour & Welfare.

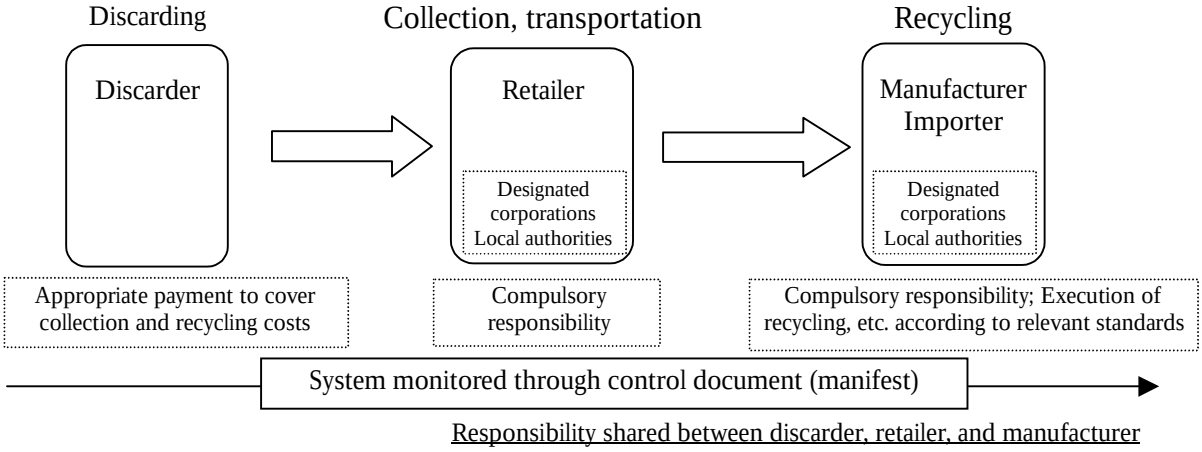
Figure 1-4. Disposal of the Four Categories of Used Home Appliances by Local Authorities



Source: Ministry of Health, Labour & Welfare.

The Home Appliance Recycling Law paves the way for the new scheme illustrated in Figure 1-5 to rectify the current situation. The scheme's framework consists of transfer of used home appliances from the discarder to the retailer and then on the manufacturer. The manufacturers or other parties then take care of recycling, and the consumer pays the cost of the scheme at the time of discarding. The whole scheme is compulsory, resulting in the construction of a new disposal channel for used home appliances, based entirely on the private sector. To deal with the portion of appliances that do not enter this system, local authorities and designated corporations will also play a marginal role. All the stages of the scheme will be monitored by means of a control document (manifest).

Figure 1-5. The New Disposal System



Source: Ministry of Economy, Trade & Industry.

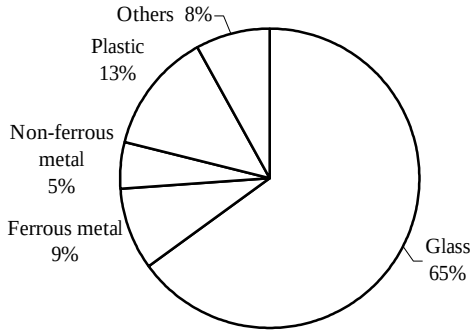
Since this scheme extends the responsibilities of manufacturers and sellers into PCW recycling, it can be regarded as an EPR-based model. In order that the scheme can work, special mechanisms have been set up in a number of areas, including:

1) Division of responsibility between manufacturers, sellers, and others
2) The recycling obligation requires 're-commercialisation', i.e. paid or unpaid transfer of the resulting goods (the recycler cannot pay other parties to accept the goods - 'reverse-payment' arrangements), with priority given to material over thermal recycling
3) Out of a number of possible options including advance payment (internalisation), delayed payment of disposal fees has been selected, so that consumers bear the costs of recycling in a visible form

Furthermore, in order to secure efficient use of resources, manufacturers and others are compelled to fulfil yearly recycling and other volume standards, as stipulated in government ordinances. This probably means that two sets of standards will be set, one for material recycling, and one for overall recycling including thermal recycling. At the start of the scheme, the following re-commercialisation rate standards have to be met for non-thermal recycling: air conditioners at least 60%, washing machines at least 50%, refrigerators at least 50%, televisions at least 55%. The four categories are each composed of materials in different proportions, but as shown in Figure 1-6 taking Toshiba's current models as an example, these standards seem to have been set so they can more or less be covered by processing of principally metals and glass. This is probably because the Japanese laws set tougher standards than Europe as described in Chapter 3: Japanese standards are for material recycling and reject reverse-payment arrangements.

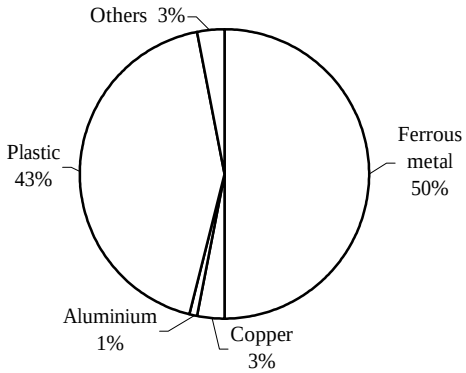
Figure 1-6. Material Proportions in the Four Categories of Home Appliances

Televisions
(Toshiba, maufactured between 1990 and 1995)



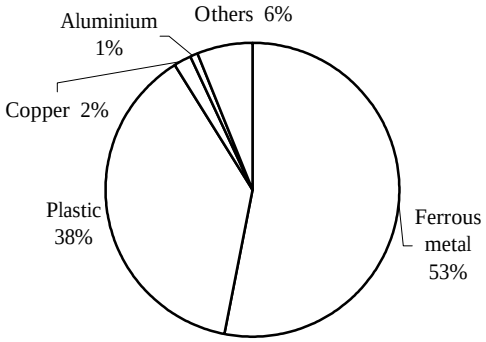
Source: Environmental Report, Toshiba

Refrigerators
(Toshiba, manufactured between 1990 and 1995)



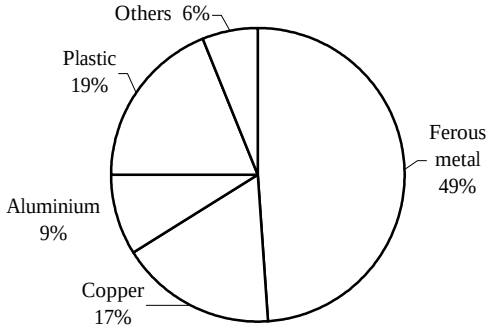
Source: Environmental Report, Toshiba

Washing machines
(Toshiba, manufactured between 1990 and 1995)



Source: Environmental Report, Toshiba

Air conditioners
(Toshiba, manufactured between 1990 and 1995)



Source: Environmental Report, Toshiba

3.2 Significance of the New System

The construction of a reverse flow, including recycling of home appliances, generally creates supplementary supply chain costs arising from the necessary transportation and processing. Whether this expenditure will cause reduction in final disposal costs that have been rising steadily due to the acute shortage of space, or cover them through profits on the sale of recycled parts and materials, and to broaden the question further, whether the new system's environmental benefits to society will outweigh the environmental burden generated in the execution of recycling, all depends on the design and construction of the system. Figure 1-7 is a conceptual diagram of reverse logistics. The efficient construction of such a system depends on factors including the following[4]:

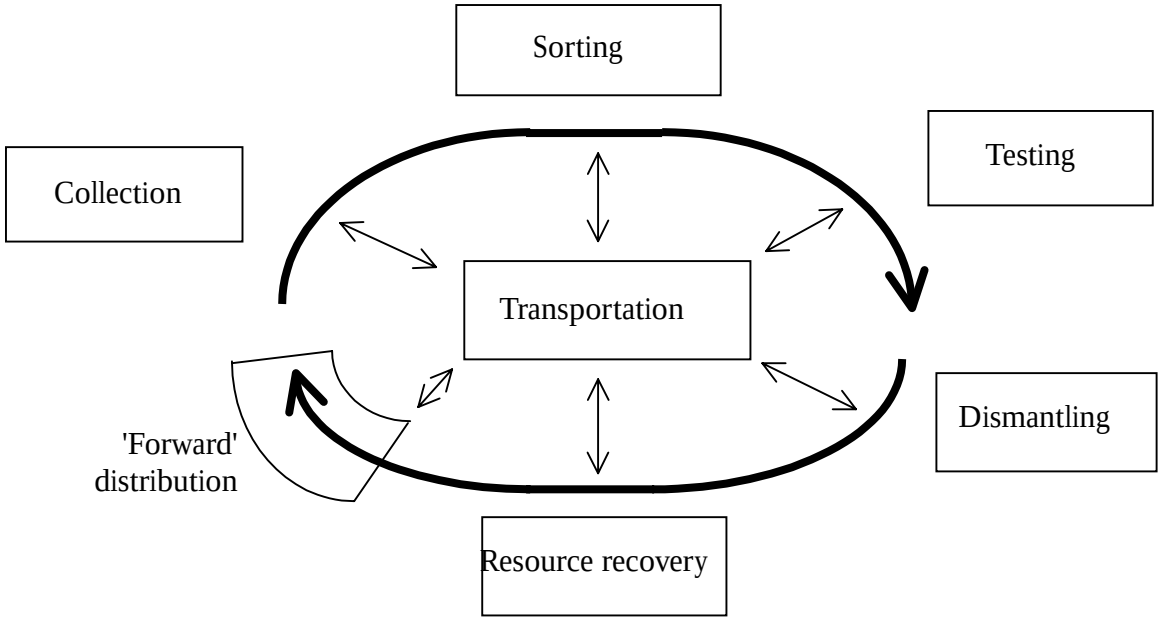
1) In order to reduce the biggest cost factor, transportation costs, intermediate processing should take place as close as possible to the discarding point, thus avoiding wasteful transportation of un-recyclable parts and materials to the recycling plant.
2) In order to raise transportation efficiency, delivery of new products and returning of waste products should use the same transportation channels.

[4] See *Reviewing Distribution Issues in Reverse Logistics*, Bloemhof-Ruwaard, Fleischmann, van Nunen.

3) The pre-processing stage of sorting has the potential to become a bottleneck in the system, making product standardisation necessary.

The introduction of the new recycling system and the ensuing activities of all the parties involved represent Japan's solution to its waste problems. The operation of a home appliance recycling system with many discarders but low transportation volume, would probably present an even greater challenge than the general considerations noted above. The system is the first example of genuine private-sector PCW recycling based on EPR, and its success or otherwise is likely to have a great influence on the development of the many recycling systems that will follow it.

Figure 1-7. Reverse Channel Functions



Source: *Reviewing Distribution Issues in Reverse Logistics*, Bloemhof-Ruwaard, Fleischmann, van Nunen.

II. The Nature of the Home Appliance Recycling Market

1. Waste Volumes of the Four Categories of Used Home Appliances, and Their Trends

The establishment of this home appliance recycling system has raised significant expectations of fuelling major growth in the so-called recycling business. In fact, the Ministry of Economy, Trade & Industry forecasts that the market scale of environmental business will reach ¥65 trillion in 2025, while the Ministry of the Environment forecasts that it will reach ¥40 trillion in 2010. The environmental business is therefore projected to grow rapidly, and it is generally assumed that the recycling sector will be its core. Within the recycling sector, what kind of weighting are home appliances likely to command?

First we will just examine the four categories of designated home appliances included from the start in the recycling system. Current waste volumes of the four categories of used home appliances are displayed in Figure 2-1, namely just under 20 million units in total annually, at a weight of 600,000-700,000 metric tons. Figure 2-2 shows diffusion rates and ownership unit volumes for leading home appliances. Patterns vary widely; for example, there are striking increases in multiple ownership of colour televisions and air conditioners, completely mature products such as refrigerators and washing machines, and products still in their diffusion phase such as video recorders and microwave ovens. As a result, waste volumes of used home appliances will also vary accordingly. We have produced simple medium-term forecasts of waste volumes, based on estimates of average length of use in years, and domestic shipment volumes. The results are shown in Figure 2-3. Looking at the next five years only, running up to when legal revisions are expected, the waste volume trends of the four categories of home appliances are not anticipated to change from that seen up to now. That is, stable overall volume of around 20 million units annually, at a weight of 600,000-700,000 metric tons, is expected.

Figure 2-1. Weight and Unit Volume of the Four Categories of Home Appliances

Unit volume ('000 units)

	Refrigerators	Washing machines	Televisions	Air conditioners	Total
91	3,323	3,774	4,640	2,025	13,762
92	3,380	3,795	4,855	2,172	14,202
93	3,447	3,831	5,136	2,360	14,774
94	3,524	3,882	5,483	2,588	15,477
95	3,625	3,958	5,886	2,889	16,358
96	3,752	4,060	6,347	3,264	17,423
97	3,850	4,182	6,841	3,606	18,479
98	3,921	4,324	7,370	3,915	19,530

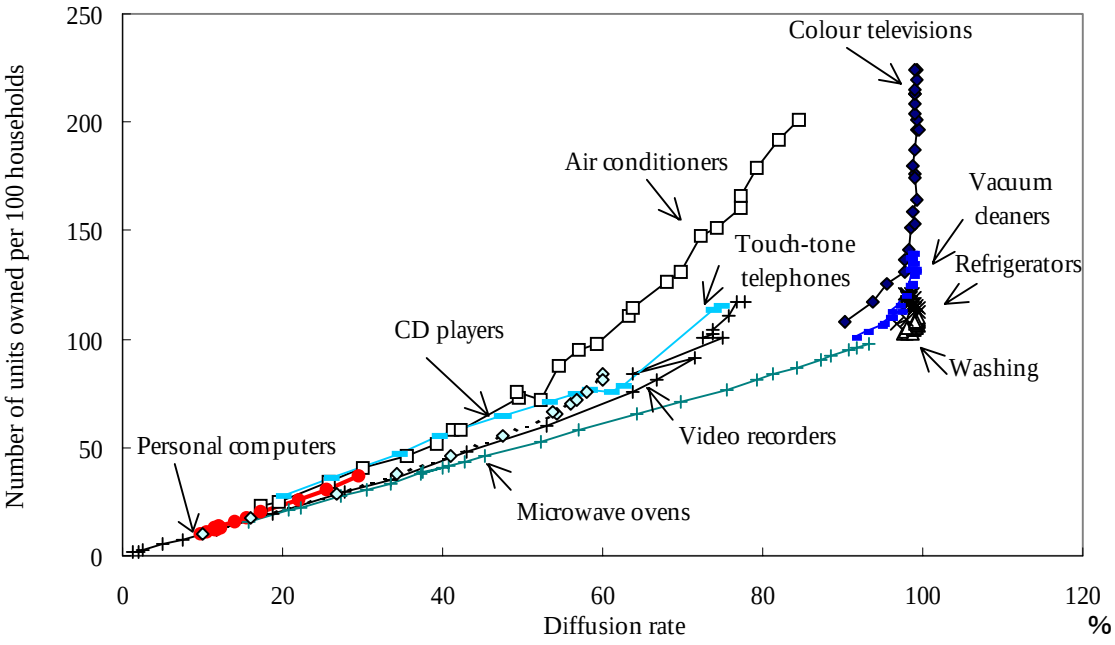
Weight (metric tons)

	Refrigerators	Washing machines	Televisions	Air conditioners	Total
91	196,057	94,350	116,000	103,275	509,682
92	199,420	94,875	121,375	110,772	526,442
93	203,373	95,775	128,400	120,360	547,908
94	207,916	97,050	137,075	131,988	574,029
95	213,875	98,950	147,150	147,339	607,314
96	221,368	101,500	158,675	166,464	648,007
97	227,150	104,550	171,025	183,906	686,631
98	231,339	108,100	184,250	199,665	723,354
Per unit weight (kg)	59	25	25	51	

Note: Weight calculated by multiplying unit volume by per unit weight

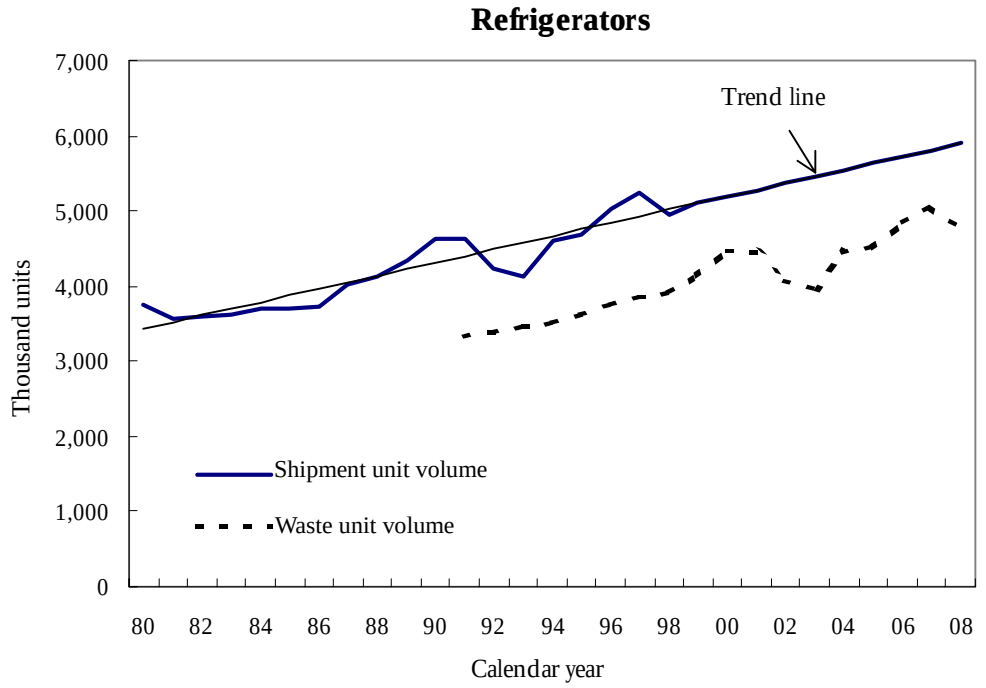
Source: *Forecast Survey Report on Waste Volume of Electric Appliances*, Association for Electric Home Appliances, etc.

Figure 2-2. Diffusion Rates and Ownership Unit Volumes of Principal Home Appliances (1975-1999)

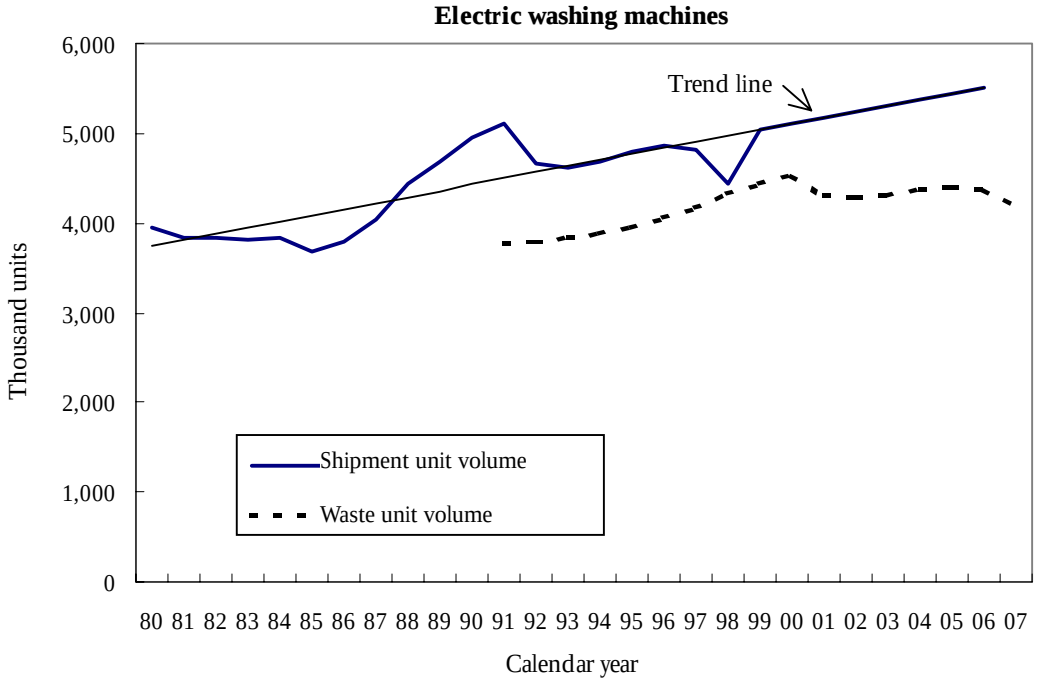


Source: *Household Consumption Trends*, Economic Planning Agency.

Figure 2-3. Domestic Shipment Unit Volume and Waste Unit Volume Trends of the Four Categories of Home Appliances

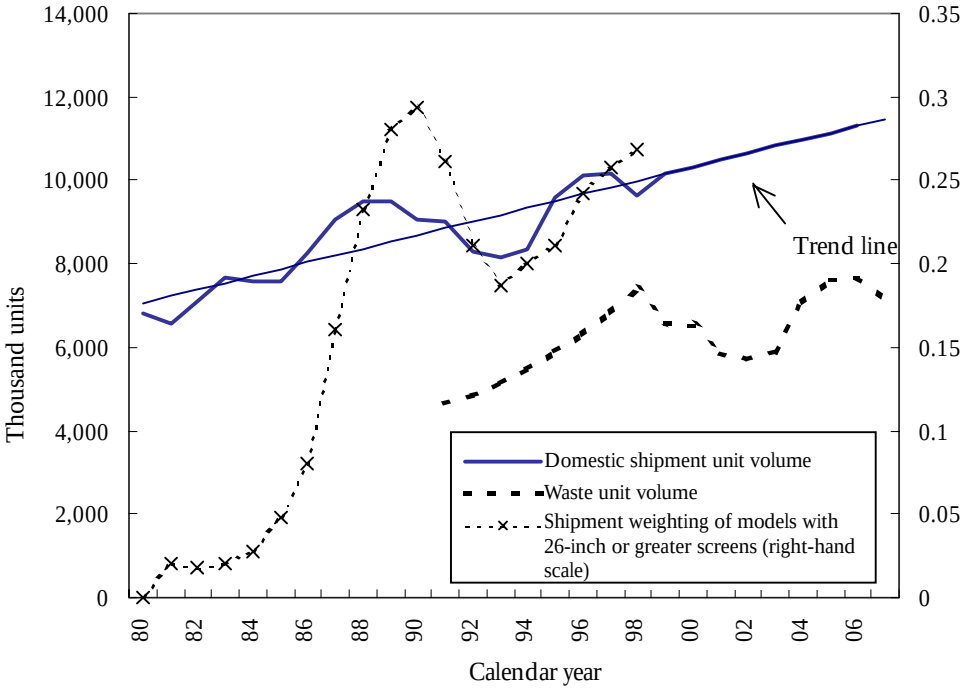


Note: Waste unit volumes are 1991-1998 estimates by the Association for Electric Home Appliances. 1999 and beyond are our estimates. Average length of use estimated at ten years.



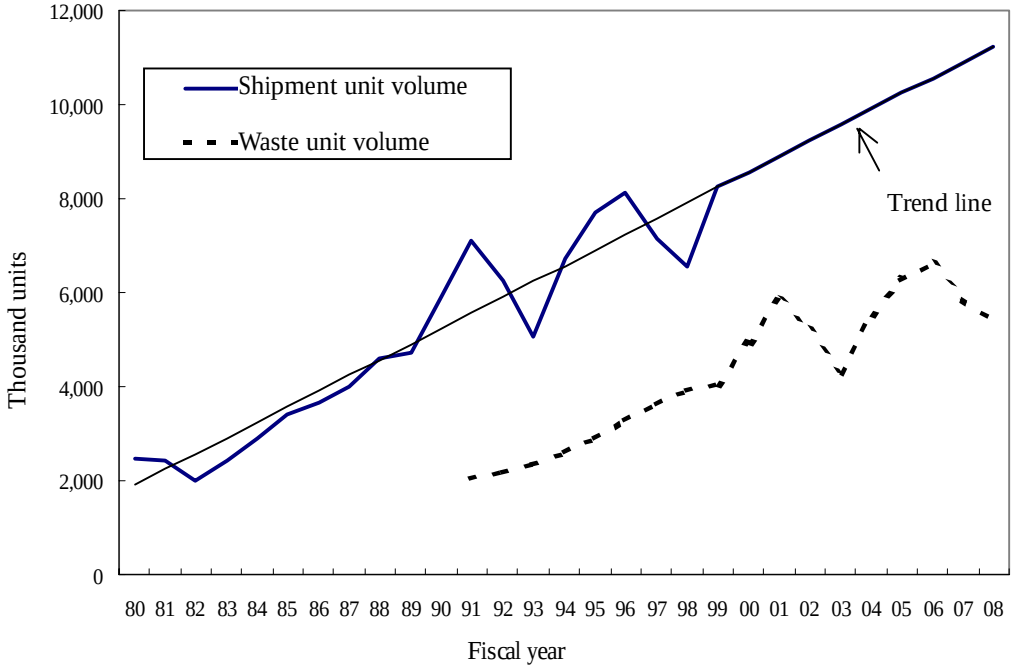
Note: Waste unit volumes are 1991-1998 estimates by the Association for Electric Home Appliances. 1999 and beyond are our estimates. Average length of use estimated at nine years.

Colour televisions



Note: Waste unit volumes are 1991-1998 estimates by the Association for Electric Home Appliances. 1999 and beyond are our estimates. Average length of use estimated at nine years.

Air conditioners



Note: Waste unit volumes are 1991-1998 estimates by the Association for Electric Home Appliances. 1999 and beyond are our estimates. Average length of use estimated at ten years.

2. Market Scale

Based on the preceding data, what kind of scale can the recycling market in the four categories of used home appliances be expected to reach? As will be described later, there are various problems that will affect the outcome, such as exportation of used goods, some recycling by local authorities that will continue after the new system is introduced, unlawful dumping, and so on. Ignoring all of these factors, and assuming that the total waste volume enters the new system, then the annual scale of the recycling market in the four categories of home appliances is expected to be around ¥100 billion (see Figure 2-4). This figure is based on estimated waste unit volume for 2005, a uniform primary transportation cost per unit of ¥1,000 (official figures for this had not been released at the time of writing this report), and the recycling fees announced by each of the manufacturers.

Figure 2-4. Market Scale Estimation

(A) The four categories of home appliances (Reference)

	Recycling fee (manufacturers' figures)	Primary transportation cost (estimate)	Total	Waste unit volume estimate ('000 units)	Market scale (¥100 million)	Yearly domestic shipment unit volume	Year	Waste rate
Refrigerators	4,600	1,000	5,600	4,521	253	5,035	96 年	89.8%
Washing machines	2,400	1,000	3,400	4,403	150	4,807	97 年	91.6%
Televisions	2,700	1,000	3,700	7,615	282	10,181	97 年	74.8%
Air conditioners	3,500	1,000	4,500	6,273	282	8,116	96 年	77.3%
Total	-	-	-	22,812	967	28,139		81.1%

* Primary transportation cost has been estimated since figures have not yet been released. The waste unit volume estimate is for 2005.

(B) Other home appliances

	Recycling fee (manufacturers' figures)	Primary transportation cost (estimate)	Total	Waste unit volume estimate ('000 units)	Market scale (¥100 million)
Other home appliances s	2,000	1,000	3,000	34,342	1,030

* Both recycling cost and primary transportation cost have been estimated. The waste unit volume estimate is 1998 domestic shipment unit volume multiplied by the waste rate (waste unit volume/domestic shipment unit volume at the time of purchase) for the four categories of home appliances.

(C) Personal computer main units, cellular telephones

	Recycling fee (estimate)	Primary transportation cost (estimate)	Total	Waste unit volume estimate ('000 units)	Market scale (¥100 million)
Personal computer main units	2,000	1,000	3,000	7,016	210
Mobile telephones	1,000	0	1,000	62,185	622
Total	-	-	-	69,201	832

* Both recycling fees and primary transportation costs have been estimated. The waste unit volume estimate for personal computer main units is 1998 domestic shipment unit volume. The mobile telephone estimate is the number of cellular and PHS telephone subscriber contracts (October 2000)/3.

(A) + (B) + (C) = ¥282,900 million

Furthermore, the number of designated home appliances is expected to rise over the medium term. We have estimated the recycling market scale of an additional 11[5] appliances also to be in the region of ¥100 billion. If the scheme is extended to the same range of electrical and electronic appliances handled in Europe, which we discuss later, and we take into account personal computers and mobile telephones (which are not currently targeted by the Home Appliances Recycling Law), then the overall annual market scale would be around ¥300 billion[6]. While not a minor market, and significant as Japan's first genuine private-sector based PCW recycling system, it will be a marginal market, given the recycling business estimates shown above. This becomes clearer when considering the many parties that will be involved, such as home appliance manufacturers, high-volume retailers, regional retailers, major logistics companies, waste disposal businesses, and so on.

The research on the German recycling market previously done by RWI is useful for considering market scale in recycling of electrical and electronic appliances. As discussed in detail in Chapter 3, the debate in Germany over electrical and electronic appliance recycling ordinances has been going on without resolution since 1991. The recycling-route replenishment rate of unregulated used appliances is currently struggling at around 30%, with a market scale of DM325-470 million (approximately ¥16.3-23.5 billion). Even anticipating a major improvement in the replenishment rate, it would probably remain a marginal market with a scale of DM1-2 billion (¥50-100 billion)[7].

3. Profitability of Recycling Plants

As described above, the scale of the recycling market for the four categories of home appliances, and even for a wider range of used electrical and electronic appliances, will be relatively small. Home appliance makers are currently preparing the infrastructure necessary to honour their new recycling obligations. Figure 2-5 gives an outline of the recycling plants that we know about so far, and we will now examine the profitability of such plants, which are being constructed with a great deal of initial investment.

We will first examine the ideal-case profitability scenario for a plant recycling the four categories of home appliances. Our assumptions are laid out in Figure 2-6: the collection points (designated exchanges) that manufacturers are obliged to set up each cover an area with a radius of 20 km, with 11 of these areas making up one region, for which one recycling plant with an annual processing capacity of 600,000 units will be needed. Based on examples announced so far, we are assuming plant construction costs of ¥1.6 billion (¥800 million for construction, ¥800 million for equipment), and fixed depreciation over their statutory life.

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5 Clothes dryers, vacuum cleaners, microwave ovens, rice cookers, electric fans, video recorders, video cameras, CD players, MD players, tape recorders, music centers

6 Of course the figure will be greatly affected by the level of recycling fees set. It is reckoned that such fees for the four categories of home appliances are roughly equivalent to around 5% of the sales price. This estimate assumes rather higher recycling fees for all of the categories.

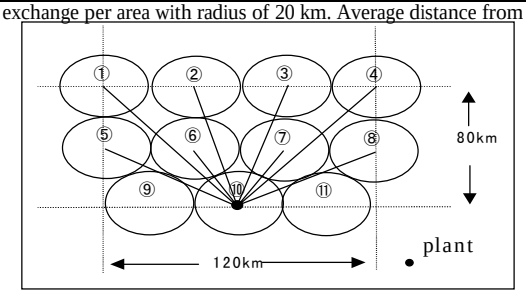
7 See Halstrick-Schwenk (2000). However, collection by German local authorities has been assumed, so the estimate is only based on recycling costs.

Figure 2-5. Main Recycling Plants for Used Home Appliances

Recycling plant	Principal investors	Annual processing unit volume	Assumed target regions
Hokkaido Ecorecycle Systems (Tomakomai City, Hokkaido)	Hitachi, Mitsubishi Materials	Home appliances: 300,000 units	Hokkaido (Ecotown installation)
Ecorecycle (Odate City, Akita Prefecture)	Dowa Mining group Sanyo Electric, Sharp, Sony, Hitachi, Fujitsu General, Mitsubishi Electric	Four categories: 300,000 units, office equipment: 200,000-300,000 units	Aomori Prefecture, Akita Prefecture, Iwate Prefecture (Ecotown installation)
East Japan Recycle Systems (Sagisawa City, Miyagi Prefecture)	Mitsubishi Materials	Home appliances: 300,000 units	Southern Tohoku region (Ecotown installation)
Kanto Ecorecycle (Ohira-cho, Tochigi Prefecture)	Hitachi	Home appliances: 300,000 units	Northern Tohoku region
Katsuta (Hitachi Naka City, Ibaragi Prefecture)	Takuma, Fujita Kankyo	Home appliances: 600,000 units	Kanto area
Hypercycle Systems (Ichikawa City, Chiba Prefecture)	Mitsubishi Electric, Ichikawa Environmental Engineering	Home appliances: 600,000 units	Kanto area
Tokyo Ecorecycle (Koto Ward, Tokyo)	Hitachi, Yumei Kogyo	Home appliances: 400,000 units	National Capital region
New company (March 2000 establishment), Kawasaki City, Kanagawa Prefecture	NKK, Mitsui, Sanyo Electric, Trienekens AG, others	Home appliances: 400,000-500,000 units	Kanto area
Fuji Ecorecycle (Fujinomiya City, Shizuoka Prefecture)	Fujitsu General, Sano Maruka Shoten	560,000 units	Shizuoka Prefecture, Yamanashi Prefecture, and environs
Kansai Recycle Systems (Hirakata City, Osaka)	Sharp Mitsubishi Materials Sanyo Electric, Hitachi, Sony, Fujitsu General, Mitsubishi Electric	600,000 units (double shift) Processing capacity: 360,000 units	Kinki region
Kanpo Recycle Plaza (Sonobecho, Kyoto)	Takuma, Kanpo	n.a.	Kinki region (Ecotown installation)
Recycle Business Network (Himeji City, Hyogo Prefecture)	Sanyo Electric, Takuma, Shin Nippon Kaihatsu	Home appliances: 400,000 units	Kinki, Chugoku regions
West Japan Recycle Systems (Kitakyushu City, Fukuoka Prefecture)	Toshiba, Matsushita Electric Industrial	500,000 units	Kyushu region

Source: Various reports.

Figure 2-6. Estimate Assumptions

<table>
<tr><th colspan="2"></th><th>Assumptions</th></tr>
<tr><td colspan="2">Facilities</td><td>Recycling processing plant: 1 location
Processing capacity: 600,000 units per year
Initial investment: Construction: ¥800 million (life: 30 years)
Machinery: ¥800 million (life: 7 years)
Total: ¥1,600 million
Leasing of site assumed (case 1: ¥50 million per year; case 2: zero)
Designated exchanges: 11 locations
Facilities are commissioned, so per unit transportation and maintenance costs, etc. payable</td></tr>
<tr><td colspan="2">Placement</td><td>One designated exchange per area with radius of 20 km. Average distance from each area to plant of 61.7 km;
 
</td></tr>
<tr><td colspan="2">Breakdown of used home appliances, etc.</td><td>Weighted average of 1998 actual waste unit volume; 37 kg per unit
<table>
<tr><th></th><th>Refrigerators</th><th>Washing machines</th><th>Televisions</th><th>Air conditioners</th><th>Total</th></tr>
<tr><td>Waste unit volume ('000 units), 1998 overall</td><td>3,921</td><td>4,324</td><td>7,370</td><td>3,915</td><td>19,530</td></tr>
<tr><td>Breakdown of above</td><td>20.1%</td><td>22.1%</td><td>37.7%</td><td>20.0%</td><td>100.0%</td></tr>
<tr><td>Unit weight (kg)</td><td>59</td><td>25</td><td>25</td><td>51</td><td>37</td></tr>
<tr><td>Plant processing capacity ('000 units)</td><td>120</td><td>133</td><td>226</td><td>120</td><td>600</td></tr>
<tr><td>Commissions (¥'000)</td><td>4.6</td><td>2.4</td><td>2.7</td><td>3.5</td><td>3.2</td></tr>
</table>
* Plant processing capacity uses proportionate division by waste breakdown of 600,000 metric tons.</td></tr>
<tr><td colspan="3">Income</td></tr>
<tr><td colspan="2">Processing income
Income from sale of valuable materials</td><td>Operating rate assumption multiplied by each unit price (recycling fee)
Processing unit volume × weight breakdown × recycling yield rate (5 stages of 60-100%) × market price
<table>
<tr><th></th><th>Refrigerators</th><th>Washing machines</th><th>Televisions</th><th>Air conditioners</th><th>Material prices</th></tr>
<tr><td>Ferrous metals</td><td>50.0%</td><td>53.0%</td><td>9.0%</td><td>49.0%</td><td>¥8,000/ton</td></tr>
<tr><td>Aluminium</td><td>1.0%</td><td>1.0%</td><td>5.0%</td><td>9.0%</td><td>¥177,000/ton</td></tr>
<tr><td>Copper</td><td>3.0%</td><td>2.0%</td><td>0.0%</td><td>17.0%</td><td>¥150,000/ton</td></tr>
<tr><td>Glass (fragmented)</td><td>0.0%</td><td>0.0%</td><td>65.0%</td><td>0.0%</td><td>¥1,200/ton</td></tr>
<tr><td>Plastics and others</td><td>46.0%</td><td>44.0%</td><td>21.0%</td><td>25.0%</td><td>Non</td></tr>
<tr><td>Total</td><td>100.0%</td><td>100.0%</td><td>100.0%</td><td>100.0%</td><td></td></tr>
</table></td></tr>
<tr><td colspan="3">Expenditure</td></tr>
<tr><td rowspan="3">Variable costs</td><td>Transportation costs</td><td>• Calculation of so-called secondary transportation costs. Assumes trans-shipment by ten-ton truck at designated exchanges. Collection weight/10 t X average running distance X operating income per km for truck transportation (¥500/km)
• Transportation costs of materials left after processing regarded as being included in recycling fee. Delivery cost to controlled disposal site assumed at ¥20,000/t.
• Transportation costs of valuable materials = unit price for actual truck days (operating income/transportation volume = ¥8645/t) X weight</td></tr>
<tr><td>Exchange costs</td><td>• Commission charges - secondary transportation costs (¥382/unit)
* ¥621/unit based on enquiries, etc. - above-mentioned secondary transportation costs of ¥229/unit</td></tr>
<tr><td>Direct disposal costs</td><td>• Estimated at ¥600/unit (including utility expenses)</td></tr>
<tr><td rowspan="4">Fixed costs</td><td>Labour costs
Depreciation costs
Site leasing costs
Interest payable</td><td>• ¥340 million: 80 plant employees, plus a few managers
• ¥127 million/year: fixed depreciation based on life of buildings and equipment
• Plant site costs; ¥50 million/year in case 1, zero in case 2
• Case 1 all funds borrowed (2%), case 2 assumed to be zero because operating funds provided by principal investors</td></tr>
<tr><td>Other costs</td><td>• ¥200 million (includes leasing charges, system maintenance and administration costs, technological training charges)</td></tr>
</table>

Income from recycling business will consist of the recycling fees charged on the four categories of home appliances, and the proceeds of sales of resources (ferrous metal, aluminium, copper, glass) recovered from the appliances.

Within overall expenditure, variable costs will consist of:

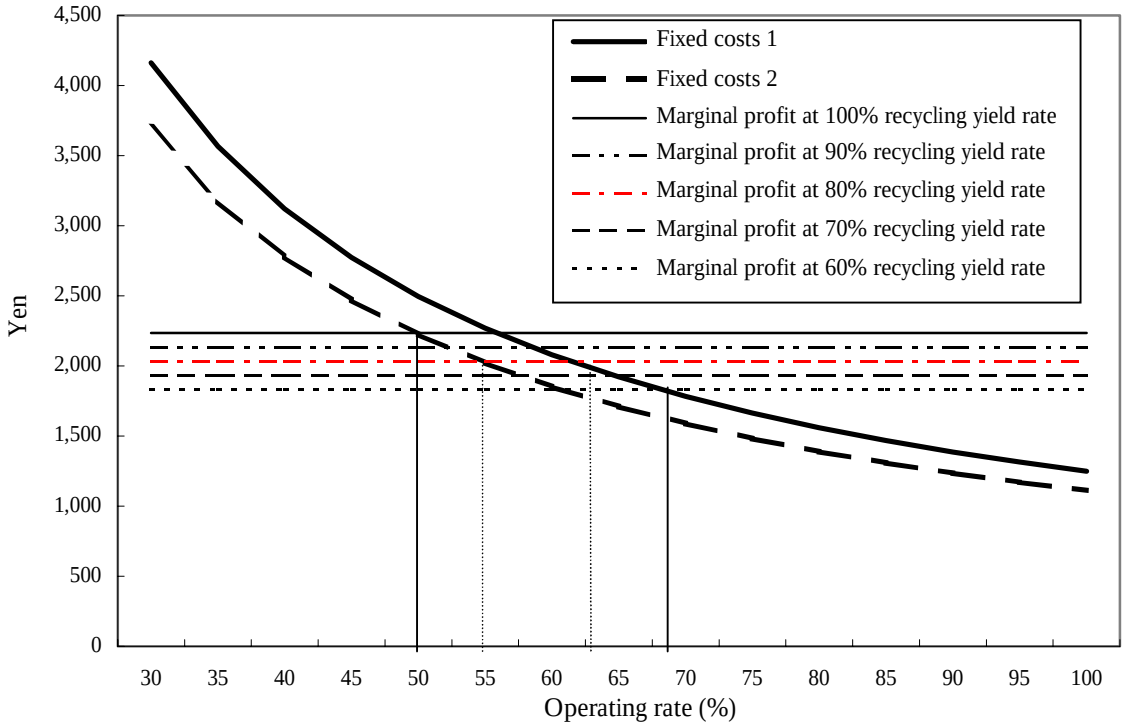
1) Transportation costs from the designated exchanges to the recycling plants (secondary transportation costs)
2) Maintenance and administration costs for designated exchanges
3) The plant's processing expenses (including utilities charges, and so on)
4) Transportation costs for valuable materials
5) Transportation and disposal costs for the materials left after processing

Fixed costs will be made up of:

1) Labour costs
2) Depreciation expenses
3) Ground rent
4) Interest payable
5) Other business expenses such as system maintenance and administration costs, equipment lease costs, etc.

Figure 2-7 shows per home appliance unit costs and profits projections based on our estimates. Since it is possible to make rough variable cost estimates, we have been able to calculate marginal profit (income minus variable costs). Income will depend greatly on the recovery rate of valuable materials (the recycling yield rate), so we have made calculations at five recovery rate levels between 60% and 100% (the horizontal lines in the chart). Variable costs can be estimated, but by contrast fixed costs, particularly ground rent and interest payable, will vary greatly depending the individual installation conditions at the plants, making case-by-case examination necessary. Furthermore, recycling will bear strong characteristics of a facilities industry, so operating rate is expected to be very influential. We have therefore presented two fixed cost cases, and given data according to varying operating rates (in other words, the extent to which home appliances enter the system compared to its estimated capacity). The figure shows the extent to which marginal profit based on our set of assumptions can cover fixed costs, dependant on the operating rate achieved; in other words, whether the break-even level can be attained. As a result, it appears that the break-even level can be broadly attained if an operating rate of roughly 50-60% is achieved. That is, losses should at least be avoided if 300,000-360,000 units of the four categories of home appliances can be collected, for a plant with processing capacity of 600,000 units. Of course, this estimate will change greatly if assumptions such as fixed costs are changed, but this level does not look difficult to attain in urban areas where large quantities of used home appliances are discarded. On the other hand, it certainly looks difficult for the nation as a whole.

Figure 2-7. Fixed Costs and Marginal Profit Per Home Appliance Unit



Note: Fixed costs 1 is all estimated fixed costs; fixed costs 2 omits ground rent and interest payable.

Source: Prepared by DBJ.

4. Barriers against the Used Home Appliance Recycling Business

There are many indeterminate factors affecting the collection of used home appliances. The most prominent of these are exportation of used goods, and unlawful dumping.

Exportation of used goods has become a business whose scale is difficult to overlook. When a low-salaried labour force is available, the valuable materials continued in Japanese used home appliances become very attractive, so pressure to purchase them is extremely strong. The main items being exported are currently audio/video equipment such as colour televisions, videos, and stereos, and air conditioners. Such goods are recycled at local plants, with remaining materials being traded as junk parts, so that even defunct appliances definitely have commodity value. One leading large-volume home appliance retailer left used goods at an overnight freight yard with a dummy manifest in the interests of research, and the consignment of mainly colour televisions was duly stolen. Exportation is not excluded by the Home Appliances Recycling Law in its section on re-use, and after exportation to developing countries most of such used home appliance are actually used in some way, either repaired, or broken down for parts and so on. At present the exportation option should not therefore be completely disregarded[8].

[8] Nevertheless, exportation of used products could well lead to liability problems, given the possibilities of inappropriate disposal of the materials left after recovery of parts, generating social costs due to pollution of soil and groundwater by harmful substances therein.

This pressure to export used goods could lead to serious problems once the recycling system has got off the ground. The biggest problem is that if the weighting of exported goods increases, the number of appliances entering the recycling system will fall, directly affecting plant operating rates. As described later, in Germany the export weighting of used electrical and electronic appliances appears to be quite high, and the same kinds of problems are believed to occur[9].

Furthermore, control of appliances in the recycling system during primary transportation in particular is likely to cause new problems. Once the system is under way, if items that have been collected are stolen for export or other purposes, the recycling fee paid by the user to the seller will have to be returned. Much time-consuming clerical work will result, such as deletion of data at the RKC[10], part of the manifest system we expect to see many sellers using. The seller also risks his reputation being damaged by being blamed for not taking sufficient precautions.

Unlawful dumping present similar problems. Unlawful dumping of used home appliances may increase to avoid primary transportation costs and recycling fees, and without adequate counter-measures this is likely to depress collection volume. Storage areas for used home appliances are a likely target for unlawful dumping, and to avoid this and thus control primary transportation costs, additional costs for installing security gates and other measures are already being incurred.

Given these indeterminate factors, and although regional variations are bound to occur, a stable average collection rate of 50-60% does not look easy to achieve. We interviewed leading home appliance makers, asking them about these points and others concerning plant profitability. The manufacturers told us that their internal deliberations were generally very pessimistic on plant profitability.

There are also concerns in some parts of the effect on collection rates from local authorities continuing to dispose of home appliances as they have done up to now. But judging by the attitudes of the local authorities that have voiced them, this should not constitute a major problem. The Tokyo City Government and various other local authorities have already started to announce that they will no longer collect home appliances as 'large waste' after the new laws come into force, and will in principle pass on responsibility to the private sector. It certainly seems that many local authorities want to take advantage of the new Home Appliance Recycling Law to remove the four categories of home appliances from the range of waste disposal for which they are responsible[11].

5. Actual Business Models

As described at the beginning of this chapter, the manufacturers that will be newly compelled by the home appliance recycling system to recycle the four categories of used home appliances, have prepared throughout the country the necessary basic infrastructure. As shown by the anticipated recycling plant profitability problems described earlier, burdensome initial investment is required. Moreover, there are many indeterminate factors affecting actual operating rates and so on, so the manufacturers are devising various schemes aimed at ensuring profitability.

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[9] According to bvse, the central body for medium and small waste disposal operators, at least 50% of WEEE is exported to countries with lower environmental standards, in order to save costs. (bvse [1999] Elektronikschrottrecycling p.8)

[10] RKC stands for recycling *ken* (ticket) centre, established by the Association for Electric Home Appliances for combined administration of recycling fees and manifests. The system provides convenient issuing of manifest tickets combined with a receipt, computer-based data checking and backing-up, and monthly settlement between sellers and the RKC of recycling fees paid by users. At least 80% of home appliance stores are expected to use the system.

[11] Over half of the 411 local authorities that responded to a questionnaire (sent to 508 local authorities) from the National City Cleaning Association said they will no longer carry out official collections.

Actual business models will differ from the above projections in not handling only the four categories of home appliances. For example, plants will be designed to handle recycling of office equipment and other items, with the aim of securing operating rate stability. A whole range of supplementary measures are being tried in order to minimise costs, such as joining forces with Ecotown to reduce the initial investment burden.

Up to now, the responses of manufacturers to these challenges can be broadly divided into two groups based on approaches to reducing costs:

1) Those attempting to reduce total costs by making the greatest possible use of existing waste processors' infrastructure (group A)
2) Those attempting to reduce total costs by setting up new recycling plants, and integrating them with an efficient logistics system (group B)

Figure 2-8 shows the characteristics of the two groups. Group A generally uses a dispersed processing system in order to keep down initial investment, while group B uses an integrated processing system, aiming to make up for the heavy initial investment burden through the efficiency of organically integrated plant and logistics functions.

Figure 2-8. Strategy Comparison for Groups A and B

	Group A	Group B
Outline	14 corporations including Matsushita Electric Industrial, Toshiba, Victor Co. of Japan, Daikin Industries Designated exchanges: 190 Recycling bases: 24	20 corporations including Hitachi, Mitsubishi Electric, Sharp, Sanyo Electric, Designated exchanges: 190 Recycling bases: 14
Scheme	• Plants regarded as research bases • Collaboration with existing waste processing businesses	• Plants set up internally in principle • Collaboration with Ecotown and other businesses • Collaboration with leading logistics businesses
Characteristics	• Dispersed model • Low initial cost burden • Strategic locating of designated exchanges possible • Ease of adjustment to volume variations • Possibility of future expansion • Improvement of secondary transportation efficiency (reduction of logistics costs) through intermediate processing at designated exchanges • Time-consuming to respond to developments affecting the entire system such as method revisions • Low dependence on home appliances means little incentive to increase the purity of resources recovered from them	• Centralised model • Large initial cost burden • Locating of designated exchanges restricted by location of existing facilities • Limited adjustment to volume variations • Complementary relationship between plants and designated exchanges • Ease of construction • Reduction of plant costs through work done at designated exchanges • Ease of response to method revisions and such • Specialisation in home appliances means strong incentive to increase the purity of resources recovered from them

Source: Unofficial enquiries, various materials.

Group A makes use of the infrastructure of existing waste disposal businesses, which means that it is able to respond flexibly to volume fluctuations, for example, if collection of used home appliances falls short of expectations. It also benefits from the future ability to improve secondary transportation efficiency through setting up intermediate processing at the designated exchanges. On the other hand, responding to method revisions affecting the entire system, such as measures affecting home appliances before they reach the plant, will be time-consuming, and low systemic dependence on the home appliances themselves means relatively little incentive to increase the purity of resources recovered from them. Group B makes use of the infrastructure of existing logistics businesses, which means that it is able to adjust transportation of home appliances flexibly to match operating conditions at plants, and the system's specialisation in

home appliances creates incentives to increase the purity of resources recovered from them. It can also respond easily to method revisions affecting the entire system. On the other hand, although group B is trying to keep down costs by collaborating with Ecotown, the initial investment in their own plants will inevitably be burdensome, and their ability to respond to volume fluctuations will be limited. There will also be location restrictions on the designated exchanges, because of reliance on existing logistics businesses' infrastructure. Therefore, both models seem to have strengths and weaknesses, but it will be difficult to judge relative superiority until they have been operating for some time.

The recycling business demands a large amount of investment in processing facilities, yet its products are classically low value-added, so centralised processing sites are necessary to achieve economies of scale. From this point of view, the splitting of the manufacturers into two groups through their response is not desirable[12], but on the other hand the development of a range of business models aimed at achieving recycling profitability, and then letting them compete efficiently against each other, is not necessarily undesirable. Both groups regard their recycling plants as research and development centres for future products designed to be easy to recycle. This is surely the real aim of legislation to compel the manufacturers, who understand their products better than anyone, to recycle, and competition in this area is what is most needed.

6. The Nature of the Home Appliance Recycling Market

We have summarised the relatively small market scale and profitability problems of the new recycling scheme, but of course these do not diminish its significance. The development of home appliance recycling is likely to bring huge social benefits, not just alleviation of the acute shortage of waste-disposal space and efficient use of resources targeted by the legislation, but also reduction of the risk of severe environmental pollution (for example, soil contamination by heavy metals) from the discharge of harmful substances, resulting from providing alternatives to preceding inappropriate forms of disposal such as burying in the original form in landfill sites. Figure 2-9 shows the range of environmental risks from harmful substances usually presented by the processing of electrical and electronic equipment including home appliances. Although not immediately obvious, this benefit of the Home Appliance Recycling Law cannot be overlooked.

[12] Among the many home appliance recycling bases, only West Japan Recycling in Kitakyushu City is used by both groups A and B. Resulting benefits include the sellers and the designated exchanges being able to save costs through not sorting the collected home appliances, and reduced concerns over the plant's operating rate. This region is expected to be an important case model for home appliance recycling.

Figure 2-9. Environmental Risks from Processing of Waste Electrical and Electronic Equipment (WEEE)

Incineration of WEEE

- Atmospheric discharge of dioxins and furanes
  →Low-temperature combustion of bromine-type flame retardant
  →Catalytic mediation of heavy-metal containing substances
  →PVC problems
- Negative energy output
- Concentration of heavy metals in slag → increased risks from slag

Landfill disposal of WEEE

- Leaching and evaporation of harmful substances
  →Soil and ground water pollution by mercury, PCBs, cadmium, etc.
  →Atmospheric evaporation of mercury, etc.
  →Generation of dioxins and furanes through spontaneous combustion at disposal sites

Recycling of WEEE

- Generation of dioxins and furanes through extrusion of halogenated plastics such as bromine-type flame retardant
- Atmospheric discharge of heavy-metal containing substances (lead, cadmium, etc.)
- Heavy metal pollution in the shredding process (in recovered metals and shredder dust)

Source: EU WEEE Proposal Directive.

The enactment of the Home Appliance Recycling Law will therefore both give rise to a form of environmental business, and improve social infrastructure through extension of manufacturer responsibility among home appliance makers and others. Perhaps the latter, however, is of greater significance.

III. Overseas Trends in Recycling of Used Electric and Electroni Appliances

1. The EU's WEEE Directive Proposal

Next we will turn to overseas trends in recycling of electrical and electronic equipment including home appliances. The most prominent example is the EU's Proposal for a Directive on Waste Electrical and Electronic Equipment (WEEE), which compels the collection and recycling of electrical and electronic equipment sold within the EU. The first draft of the proposal was promulgated in April 1998, and after many adjustments to the scope of targeted equipment and the enactment timetable, it was adopted by the EU Commission in June 2000. Together with the simultaneously adopted Proposal for a Directive on the Restriction on the Utilisation of Hazardous Substances in Electrical and Electronic Equipment[13], and the Proposal for a Directive on the Environmental Effects of Electrical and Electronic Equipment which is currently being debated, the directive sets EU regional standards for such equipment from the design to the disposal stage.

The EU's environmental policy has been gradually strengthened since environmental regulations were introduced into the European Community Treaty by the Single European Agreement that came into force in 1987. By now environmental considerations must in principle be respected in all EU-wide policy initiatives, in order to ensure sustainable development. However, because regulations often create uneven merits and demerits among the member states, most initiatives are now in the form of directives, which just set objectives, leaving the attainment of those objectives up to the internal legislature of the member states. The current directive proposal is part of the trend outlined above, and attempts mainly to bring about convergence in the differing measures taken by the member states to promote WEEE recycling and against hazardous substances (see Figure 3-1). After its adoption by the European Council, the member states are to enact the necessary domestic legislation to conform to it.

The main characteristics of this directive are generally regarded to be:

1) A broad spectrum of targeted items
2) High recycling rates
3) Regulations on hazardous substances (although these have finally been transferred into a separate directive)

As shown in Figure 3-2, the range of targeted equipment is indeed very broad, covering 79 items in 10 categories, from home appliances to vending machines.

[13] This directive stems from part of the original WEEE directive proposal banning the use of specified substances such as mercury and cadmium by 2004. However, manufacturers demanded a longer lead-time to develop replacement substances, and due to criticism that it constituted a trade impediment beyond the needs of attaining reasonable goals and thereby infringed WTO/TBT rules, it was split off and revised into a separate directive proposal.

Figure 3-1. Outline of the WEEE Directive

<WEEE regulations in leading EU member states>

Denmark (Legislative Order)
- Local authorities obliged to collect WEEE, financed by local taxes and commission charges

Italy (Waste Processing Order, 1997)
- Collection of home appliances and other consumer durables compulsory
- End users compelled to take items to recognised sellers or public waste depots

The Netherlands (WEEE Law, June 1998-)
- End users pass WEEE to sellers or local authorities free of charge
- Appropriate disposal by manufacturers and importers compulsory; landfill disposal and incineration banned in principle

Sweden (WEEE Regulations, July 2001-)
- Consumers can pass WEEE to sellers or local authorities
- Recycling costs borne by local authorities or manufacturers
- Disposal must be performed by recognised operators; landfill disposal, incineration, shredding not allowed

Belgium (Flanders region, 1998-)
- Manufacturers, importers, distributors, and sellers compelled to accept WEEE free of charge
- Setting of recycling targets for ferrous metal, non-ferrous metal, and plastic

Germany
- Continuing debate on WEEE Ordinance

<Principal regulations covering use of hazardous substances>

Austria
- Regulations governing lead-containing fertilisers and heavy metal-containing sludge
- Use of cadmium in cosmetics, etc. banned
- Limits on volume of mercury used in fluorescent lighting
- Use of PBB banned (1993)

Finland
- Regulations governing lead-containing fertilisers and heavy metal-containing sludge

Denmark (under consideration)
- Regulations governing lead-containing products
- Sale of lead-containing products banned in principle

Sweden
- Initiative to eradicate progressively the use of lead-containing products (cables, solder, light bulbs, cathode ray tubes, etc.)
- Banning of PBDE and PBB under consideration

The Netherlands
- Cadmium Ordinance (1999) banning use of cadmium in drawing materials, dyes, plating, etc.
- Progressive eradication of the use of mercury (1998)

WEEE Directive (proposal) ⇐ EU-level common standards ⇒ Directive on the Restriction on the Utilisation of Hazardous Substances in Electrical and Electronic Equipment (proposal)

- Different regulations within member states, with varying levels of corporate contribution
- Different WEEE processing policies within member states leads to transportation of waste, harming the efficiency of domestic recycling policies
- Different policies within member states regarding progressively banning the use of specified substances affects trading in electrical and electronic equipment
- Environmental pollution from processing of WEEE crosses frontiers
- Ensuring a regular volume of waste is essential for efficient WEEE recycling

Source: Produced from the EU proposal draft and other materials.

Figure 3-2. Electrical and Electronic Equipment (EEE)

EEE is defined as equipment dependent on electrical current or electrical magnetic fields for normal functioning, and equipment for generating, transporting, or measuring such electrical current or electrical magnetic fields, and is divided into the following categories. However, only equipment using electricity of less than 1000 volts AC or 1500 volts DC is included.

Category	Examples
1. Large home appliances	Washing machines, refrigerators, microwave ovens
2. Small home appliances	Vacuum cleaners, irons, coffee makers
3. IT and communications equipment	Personal computers (including peripherals), copiers, telephones
4. Audio/video equipment	Radios, televisions, video recorders, musical instruments
5. Lighting equipment	Fluorescent lighting, sodium lighting
6. Electrical and electronic tools	Drills, saws, sewing machines
7. Toys	Video games, electric train sets, electric cars
8. Medical equipment systems	Radioactive treatment equipment, dialysis equipment, iron lungs
9. Monitoring and control equipment	Thermostats, smoke sensors
10 Vending machines	Drink vending machines, solid-goods vending machines

Source: EU directive proposal draft.

As shown by the recycling rates in Figure 3-3, 50-80% by weight is required from 2006. However, it should be stressed that this EU recycling rate is founded on a different concept to Japan's re-commercialisation rate contained in the Home Appliance Recycling Law. That is, Japan's re-commercialisation rate is calculated from recycled goods transferred in return for payment or free of charge, and excludes collection based on reverse-payment arrangements. By contrast, the EU's recycling rate makes no distinctions over exchange value. Accordingly, under the Japanese recycling system most waste plastic is not counted in re-commercialisation rates, even if it is processed to a high degree as a blast furnace reducing agent for example, whereas it would be included in the European recycling rate without argument. This situation results from differences in concept definitions between the EU and Japan. Therefore, although it is generally thought that high recycling rates are a characteristic of the EU system, at least on a comparison with Japan, this is not necessarily so.

Figure 3-3. Outline of the EU's WEEE Directive Proposal

Collection and sorting
• EU member states are to work towards attaining the target of collection and sorting of 4kg of WEEE per head of population annually by January 2006 at the latest.
Processing
• EU member states are to take the necessary measures for manufacturers to attain the targets set out below by January 2006 at the latest. 1) Large consumer equipment: 80% per unit (average weight basis) Over the same period re-use and recycling rates for components, parts, etc. are to reach at least 75% per unit (average weight basis) 2) Equipment in categories 2, 4, 6, and 7 (excluding cathode ray tube assemblies): 60% per unit (average weight basis) Over the same period re-use and recycling rates for components, parts, etc. are to reach at least 50% per unit (average weight basis) 3) All equipment in category 3 (excluding cathode ray tube assemblies): 75% per unit (average weight basis) Over the same period re-use and recycling rates for components, parts, etc. are to reach at least 65% per unit (average weight basis) 4) Re-use and recycling rates for components, parts, etc. of gas/electric discharge lighting are to reach at least 80% per unit (average weight basis) 5) All cathode ray tube assemblies: 75% per unit (average weight basis) Over the same period re-use and recycling rates for components, parts, etc. are to reach at least 75% per unit (average weight basis)
Monitoring
• By January 2005 at the latest, the EU Commission is to decide the details of rules for monitoring attainment of target values by member states.

Source: EU directive proposal draft.

Compared to the above, the EU's proposed approach to hazardous substances (see Figure 3-4) provides a clear contrast with Japanese regulations[14]. Japan's Home Appliance Recycling Law does not touch on banning the use of, or replacing, hazardous substances, but as noted above by its nature the appropriate recycling and processing of home appliances includes restricting the release of hazardous substances contained in them into the environment, and this is an extremely important benefit of the EU system. For reference, an outline of the various benefits of the EU's WEEE directive proposal is presented in Figure 3-5.

Figure 3-4. Outline of Regulation Directives on Hazardous Substances

• EU member states guarantee to replace lead, mercury, cadmium, sexivalent chromium, PBB, and PBDE used in electrical and electronic equipment with other substances by January 2008. • However, in the few cases where replacement substances are worse for the environment, or replacement is technologically impossible, the list of targeted hazardous substances will be revised. The EU Commission is to re-appraise these sections in the light of the necessary scientific information by January 2004.

Source: EU directive proposal draft.

[14] The rules on hazardous substances are contained in different directives, but we are treating them as a part of the WEEE initiative for the purposes of this report. Rules relating to hazardous substances are also included.

Figure 3-5. Benefits of the EU's WEEE Directive Proposal

Financial benefits	
• Restriction of production costs through replacement of primary commodities with secondary raw materials	
• Restriction of waste costs through development of re-use and recycling	Lower costs for transportation to disposal sites, and processing to remove hazardous substances from shredder dust
• Finally, design improvements, etc. to reduce the cost of reuse and recycling itself	
External benefits	
Principal external benefits from collection/sorting, and recycling	
• Avoidance of external costs through re-use of resources contained in WEEE (sustainable resource use)	Assuming a collection volume of 4kg per head, at least one million metric tons per year of substances will return to the economic cycle
• Avoidance of external costs generated by the environmental impact of incineration and landfill burial of WEEE	After appropriate collection and processing, only 10-30% of pre-processing weight to be finally buried in landfill sites
	External costs generated by the current pattern of WEEE disposal are clearly greater than from disposal of other items, given the hazardous substances contained in them. Worst of all are refrigerators containing CFCs, and equipment incorporating cathode ray tubes
• Avoidance of external costs generated by the environmental impact of using primary commodities	Energy savings from recycling of WEEE are estimated at 120 million GJ annually (equivalent to 2.8 million metric tons of oil). This is a 60-80% saving compared to using primary commodities
Principal external benefits from design improvement and removal of hazardous substances	
• Electrical and electronic equipment design improvement should not only help to reduce personal re-use and recycling costs, but also lessen the impact on the environment at the disposal stage	Estimating the scale of these effects is difficult because they depend on action taken by individual states, and market reactions
• The impact of reducing the use of hazardous substances in electrical and electronic equipment expected to be significantly large, given their toxicity and ability to permeate through the environment	Conversion into monetary value is difficult because of insufficient specialist knowledge of pollution exposure channels and ecological reactions

Source: EU directive proposal draft.

Based on all the points noted above, Figure 3-6 provides a comparison on EU and Japanese recycling schemes. To re-cap, the EU system displays the following characteristics in contrast to the Japanese system:

1) Targeting of a wide spectrum of equipment
2) Recycling costs to be borne by the manufacturer, with mechanisms to cover items sold up to five years ago

3) Collection and sorting target values have been set (4kg per head of population annually)[15]
4) Member states are responsible for their own collection systems

Figure 3-6. Comparison of European and Japan Recycling Scheme (Proposed Scheme)

	Home Appliance Recycling Law (Japan)	WEEE Directive Proposal (EU)*
Targeted waste (annual waste volume)	Home appliances (air conditioners, washing machines, refrigerators, televisions) specified by governmental ordinance (600,000-700,000 metric tons per year)	Electrical and electronic equipment (8 million metric tons per year)
Objectives	Appropriate processing of waste, efficient use of resources (attainment standards set)	Waste reduction, re-use, recycling (attainment standards set)
Product demands	• Increased product life • improvement of repairs system • ease of recycling to be raised through efforts in design and selection of components and raw materials	• Banning of use of hazardous substances (by 2008) • reduction of use of plastic • Code number regulations for components and materials • Ability to be repaired, adapted, re-used, broken down, and recycled • New products to attain recycled plastic re-usage rate of 5% (by 2004)
Seller requirements	• Obligation to handle goods sold in the past, and goods in the same categories • Obligation to pass on such goods	None
Funding required	• Retailers allowed to seek payment for collection and transportation costs when goods accepted • Manufacturers allowed to seek payment of recycling and other costs	• Member states to decide collection fees • Manufacturers to bear the cost of recycling new products • Interim measures covering five years for products sold in the past
Limitations	Revision after five years	• Mechanisms to cover items sold up to five years ago
Collection methods	• Retailers obliged to accept goods (goods sold in the past, and goods in the same categories) • Manufacturers to organise designated exchanges • Collection by local authorities and designated corporations	• Member states decide their own methods
Collection rates	None	• Target value: 4kg per person per year; • Binding value to be set from 2006
Recycling rates (weight basis)	• Televisions: 55%; • Refrigerators: 50%; • Washing machines: 50%; • Air conditioners: 60%	• Large home appliances: at least 75%; • Small home appliances: at least 50%; • Gas/electric discharge lighting: at least 80%; • Appliances using cathode ray tubes: at least 70%; etc.

Note: EU regulations covering usage of hazardous substances included with WEEE Directive Proposal

Source: Produced from *Explanation of the Home Appliance Recycling Law*, Ministry of International Trade and Industry; *Elektro- und Elektronikschrottverwertung*, bvse, and other materials.

[15] If the target is reached, the EU's overall collection volume will be upward of 1.5 million metric tons (= 4kg x 375 million people). Given Japan's population, the equivalent figure would be 480,000 tons (= 4kg x 120 million people), which should be achieved if around 80% of the waste volume of the four categories of used home appliances is collected; the EU target is not therefore exceptionally high.

The introduction of five-year interim measures covers products that have been made up to now without the assumption that they were to be recycled, and reflects internal and external opposition within and without to makers immediately making a greater contribution to recycling. This also became a contentious issue in Japan when advance or delayed payment of the costs of collection and recycling was under discussion. As already described, Japan is introducing a delayed payment scheme, i.e. the recycling fee is paid after the product has been used and is being discarded.

Collection methods are being left to the EU member states to decide for themselves, probably reflecting the wide range of methods that will be used. However, as seen above it is difficult to imagine a universal collection system that can cope with all the various kinds of appliances, and their varying collection requirements. Therefore, we expect that collection will depend largely on public authorities.

Incidentally, the draft of the EU directive proposal estimates the resulting costs of WEEE collection and recycling at around 500-900 million euros annually (15 nation basis). Within this, collection costs are anticipated at 300-600 million euros, and recycling costs at 200-300 million euros. The estimates are based on the experiences of member states that have run their own recycling systems including other considerations, but since a centralised collection system is not being set up, it is not clear exactly how many calculations were made. Nevertheless, the overall market scale estimate is equivalent to ¥47.5-85.5 billion, showing that even on the scale of the region covered by the EU's directive proposal, WEEE recycling will be a relatively small industry.

In conclusion, from 2006 a wide range of electrical and electronic equipment sold within the EU region will be subject to member state regulations based on this directive. Although it is difficult to predict many future developments, replacement of the specified substances at least has to take place by 2008. It goes without saying that the introduction of such regulation in such an important market as the EU, will have a direct impact on Japanese home appliance makers. Furthermore, since there is quite a history of regulation developed in the EU later becoming the international *de jure* standard, it may also in time have an impact on the Japanese domestic market.

2. The Situation in Germany

So how will EU member states respond to the WEEE directive? We will next examine the case of Germany.

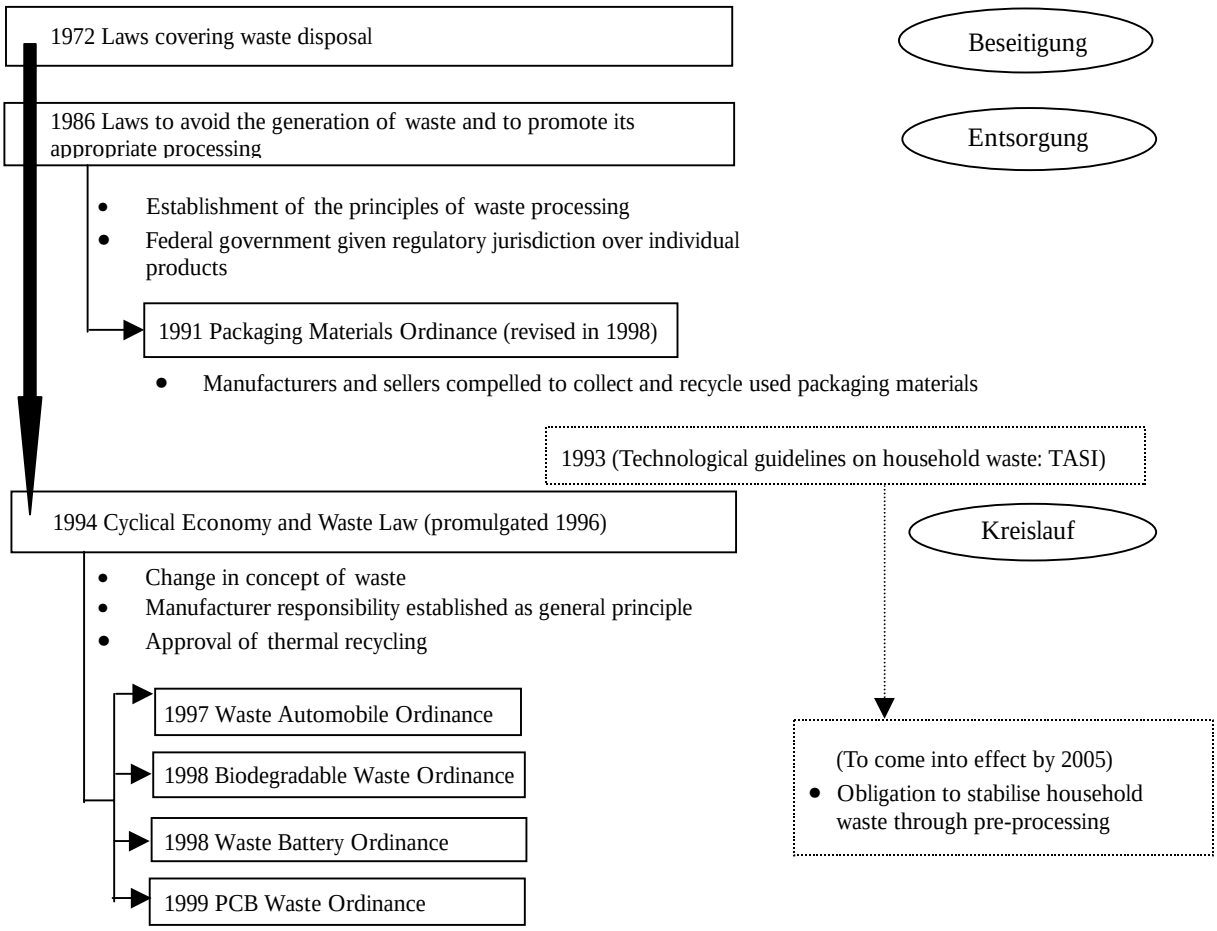
2.1 Outline of German Recycling Policy

As has been made clear already, German recycling policies are a source of interest and an object of research for policy-makers in Japan. Probably this partly stems from similarities between Japan and Germany in industrial structure, adoption of related market economic systems, and the shared tendency towards the state taking a major role in social systems. In fact, in the pioneering of environmental policies such as recycling, the lead is frequently taken by a nation that previously lacked a significant domestic industry in that particular field, although it is difficult to make any predictions regarding the current case.

In Germany, waste processing is classified within the scope of competitive legislation[16], which means that federal law takes precedence. Consequently, the development of recycling policies can be grasped by examining the history of federal-level legislation, which we will outline first.

[16] 'Competitive legislation' (Konkurrierende Gesetzgebung) indicates a broad arena in which both the federal government and the individual German states can legislate. In principle, federal law takes precedence over state law (Basic Law, Section 31), so subsequent federal legislation in areas where state laws already exist makes the state laws invalid.

Figure 3-7. The History of German Waste Processing Legislation



Source: Prepared by DBJ.

Federal laws covering waste disposal were introduced in 1972, at a similar time to Japan's waste and cleaning laws established by the so-called pollution Diet in 1970. The word for waste 'disposal' in Germany's 1972 law is 'Beseitigung', which literally means 'clearing away', reflecting the law's focus on the removal of waste from the usual sphere of human activities, purely based on public health considerations, and therefore of little relevance to the current report. No major changes then took place until the late 1980s, when waste policy was overturned by the 1986 Laws concerning Appropriate Disposal of Waste and Avoidance of its Generation, which clearly delineated the future direction of waste disposal policy. Its two main characteristics are as follows.

Firstly, the new law displayed the order of priorities regarding waste disposal, namely avoidance of its generation, followed by its recycling, and then its appropriate disposal. The same concept is enshrined in Japan's Waste Disposal Law, and from today's standpoint it does not appear remarkable, but as the first legal delineation of this principle it was a milestone.

Secondly, in order that the above principle could be applied, the government was given the authority by means of special laws to regulate specific products in order to reduce waste. Consequently, the Packaging Materials Ordinance was introduced in 1991 targeting containers and packaging materials, and this was the pioneer of the policy mechanism whereby the scope of recycling legislation would grow to encompass new individual products, founded on the basic law.

In 1994, the 1986 law was further developed by the Cyclical Economy and Waste Law

(enacted in 1996), which became a new basic law. Well known in Japan, this law furthered the principles of the 1986 law, while also introducing some new ones. Among notable areas such as changes to existing concepts of waste (Section 3)[17], and paving the way for thermal recycling (Sections 4 and 6), perhaps the most prominent development was the principle of product responsibility (Produktverantwortung). As shown in Figure 3-8, Section 22 of the Law compels manufacturers at development, production, and sales stages of a product to strive to meet the standards required by law in avoidance of waste generation, environmentally-friendly recycling, and final disposal, within the limitations of current technology. This responsibility was defined for each individual product in the relevant product ordinances introduced by the federal government, and so was not able to be generally applied just using the basic law. However, after making its debut in the 1991 Packaging Materials Ordinance, extended producer responsibility (EPR) was also enshrined in the basic law, and it is significant that this doctrine is universally and thoroughly respected in all the related individual product regulations. A range of special laws have been introduced to supplement the basic law, including the Waste Automobile Ordinance[18] (1997), the Waste Battery Ordinance (1998), and the Biodegradable Waste Ordinance (1998), and the range of products being recycled is increasing.

2.2. The Recycling System Established by the Packaging Materials Ordinance, and Its Significance

The Packaging Materials Ordinance was the pioneer of current government policy in Germany. It compels manufacturers and distributors to collect and recycle packaging materials, in a disposal system separated from those operated by local authorities. The system that has resulted is well known in Japan, but we will recapitulate it here in order to compare it with the Waste Electrical and Electronic Equipment Ordinance described later.

Among the businesses compelled by the ordinance to collect and recycle packaging materials produced or sold by them, over 600 jointly established Duales System Deutschland AG (DSD). In cases where businesses compelled to collect and recycle packaging materials do not fulfil their duties themselves, they use DSD. The 'der grüne Punkt' (green spot) logo on packaging indicates that it will be disposed of by the DSD system, and manufacturers are permitted to use the logo on their products after paying the appropriate licence fee. The licence fee is adjusted to reflect the level of recycling difficulty, and is different for each type of packaging material.

The discarders of packaging material waste, the consumers, sort product packaging materials bearing the green spot logo from their regular waste, and it is collected through a special system set up by DSD[19]. DSD collects and recycles the packaging materials, with its costs provided by the licence fees it receives from manufacturers.

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[17] Waste (Abfälle) is defined in this law as that which is generated by the activities of production and selling, including a wide range of movable property (bewegliche Sachen) to be disposed (entledigen) of (intentionally, compulsorily) by the owners, and which is divided into waste which can be efficiently re-used, recycled, etc. (Abfälle zur Verwertung), and waste for disposal (Abfälle zur Beseitigung). This changed the existing concept of waste insofar as it excluded subjective factors from the ownership and possession of movable property to be disposed of, and provided clear definitions for the presence or absence of exchange value.

[18] The original Waste Automobile Ordinance is based on self-regulation (including free collection of autos of a certain age) by the automobile industry association, and does not touch directly upon manufacturer responsibility. However, there are too many loopholes in the current regulations, and the Special Committee on Environmental Problems suggests revisions in its 2000 report.

[19] The system includes separate collection boxes for different colours of glass and special yellow bags for plastic packaging materials. Many features of the German system have been introduced to Japan.

Figure 3-8. Manufacturer Responsibility as Expressed in the Cyclical Economy and Waste Law

Principal content relating to manufacturer responsibility

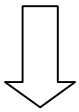
1) To develop, produce, and sell durable and repeatedly-usable products that after use can be recycled lawfully and harmlessly, and disposed of with low environmental impact

2) To make preferential use of recycled materials and recovered resources

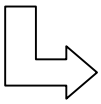
3) When products contain harmful substances, to give clear notification of this on them, in order that their waste is recycled or disposed of with low environmental impact

4) Instructions on returning, re-use, and recycling, and guarantee payments rules to be displayed on products

5) To accept, recycle and dispose of products and used products



Parties involved in the development, production, processing, and selling of products are to take manufacturer responsibility and abide by the law. In order to fulfil manufacturer responsibility, the generation of waste from products should be restricted as much as possible during the production and usage stages, and must be designed to enable recycling and disposal after use with low environmental impact



Authority vested in the Federal Government (Section 23, 24)
Introduction of regulations to define manufacturer responsibility for individual products, after consulting with affected parties and obtaining the consent of the Federal Upper House.

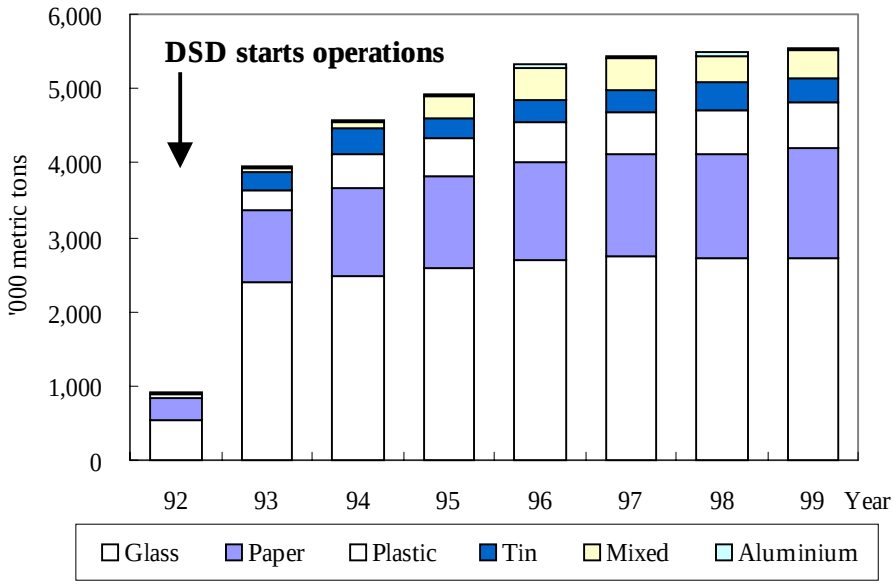
Source: Cyclical Economy and Waste Law.

Although the system established by the Packaging Materials Ordinance summarised above inevitably ran into a number a problems[20] at its inception, as shown in Figure 3-9, the system gradually settled down and DSD's earnings improved, so that it was able to change from a limited company into a joint-stock company in 1997. In the meantime business commissions and so on from DSD have stimulated huge growth in recycling enterprises, and the successful system that resulted has become the *de facto* standard for continental Europe.

The success of the system is to a large extent thanks to sorting of waste (to a relatively high level) by consumers, made possible by economic incentives. According to Germany's Local Authorities and Public Organisations Law, general administrative services are to be financed as much as possible by commission charges. Collection of household waste is no exception, with residents paying their local authorities waste disposal fees under the previous system. The start-up of DSD meant packaging waste using a different disposal system, so the volume of waste handled by local authorities on behalf of consumers was reduced, and so were the fees paid. The success of DSD seems to lie in the skilful use of such economic incentives, technological innovation, and the automatic sorting of waste.

[20] Early problems included large losses, probably resulting from businesses using the system without paying their licence fees, and 'pollution export' scandals from waste being passed on to other countries due to plastic recycling technology being insufficiently developed.

Figure 3-9. The Volume of Used Packaging Materials Recycled by DSD



Licence fees charged by DSD did not change from 1994 until they were lowered with the revision of the Packaging Materials Ordinance in 1998[21]. This was in marked contrast with the rise in disposal unit price seen among local authorities over the same period. The various reasons for this rise are discussed later.

To re-cap, Germany's waste policy is based on the concept of minimising the generation of waste, and recycling unavoidable waste. This is realised through extension of the scope of manufacturer responsibly, and development of the appropriate processes for individual products. The policy was first applied in packaging materials, where thoroughgoing introduction of EPR has resulted in the construction of a fully private-sector system. The success of DSD also appears to have reinforced the trend towards using the private sector to implement German waste and recycling policy. However, there have been problems. As waste is increasingly channelled through private-sector systems, local authorities have had to invest large sums in intermediate processing facilities and final disposal sites, in order to comply with strict environmental regulation in areas such as protection against emissions[22]. In principle, local authorities must finance this investment from volume-based commission fees, but this has been made difficult by lower operating rates as waste is increasingly channelled through the private sector. This is just one of the outstanding problems in Germany. Nevertheless, there is no change in the trend towards expanding the range of products that must be recycled, based on the framework of the Cyclical Economy and Waste Law.

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[21] The main points of the August 1998 Packaging Materials Ordinance Revision included tightening of policy on businesses fulfilling their legal obligations themselves (Selbstentsorger), without recourse to the services of DSD, by compelling them to prove that appropriate disposal is carried out, and the introduction of competitive principles, in order to resolve problems that had arisen since the system was first introduced in 1991. Furthermore, it has been decided to charge a deposit of 0.25 euros (0.5 euros for containers of 1.5 litres or more) on glass and plastic (PET) bottles and other drink containers that are not recycled and are considered to have a high impact on the environment (ökologische nachhaltige Getränkeverpackung), so a further revision to reflect this is expected sooner or later.

[22] According to the technological guidelines on household waste (TASI) which are still in their preparatory stage before implementation in 2005, improvements in intermediate and final disposal of household waste are compulsory, which will further increase the financial burden on local authorities.

2.3 Trends in German WEEE Recycling Policy

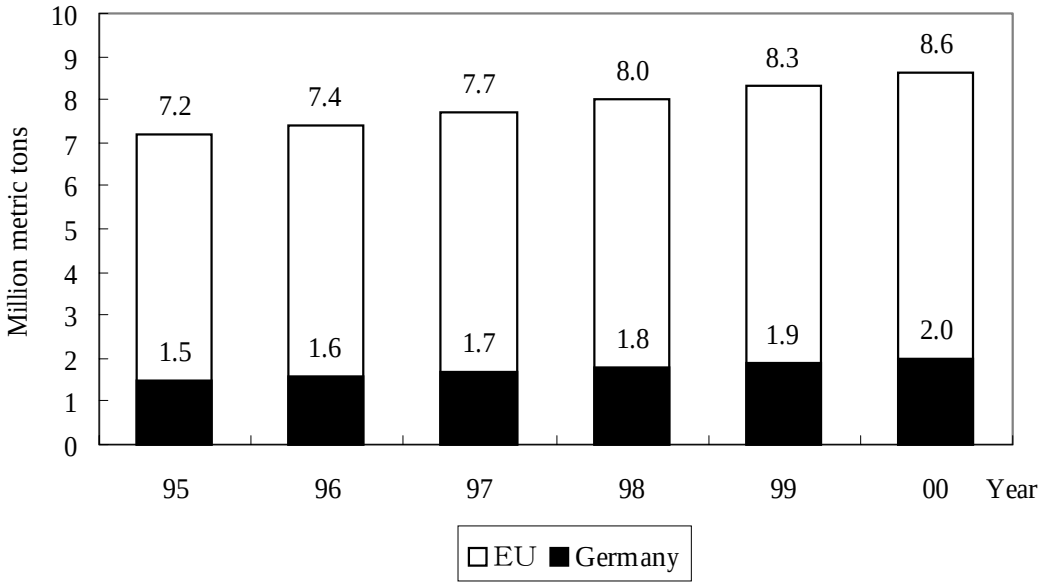
Waste electric and electronic equipment (WEEE) has of course come within the scope of German recycling policy. The regulatory definition of WEEE is as broad in German regulations as it is in EU regulations. The outline presented in Figure 3-10 shows that German WEEE reached an annual volume of around 1.8 million metric tons as of 1998, equivalent to just over 20% of the EU total. As equipment demand expands the volume of waste is projected to rise at an annual rate of approximately 5-10% over the next ten years (see Figure 3-11).

Figure 3-10. Outline of German Electric and Electronic Equipment Recycling Volume (1998)

Category	Waste volume ('000 metric tons)	Break-down	Equipment examples	Comments
Household equipment, (large equipment), (small equipment)	630 (570) (60)	35.0% (31.7%) (3.3%)	Refrigerators, washing machines, vacuum cleaners, toasters	• Most to be collected by local authorities' systems • Weighting of plastic (weight basis - same henceforth) relatively low in large equipment, making recycling easier. 3.4 million metric tons of metal recovered annually • Only around half of the total waste volume (130,000 metric tons) of small equipment is collected, so much is disposed of as household waste • Weighting of plastic high in small equipment (at least 50% on average), and the large number of equipment types, makes manual dismantling uneconomic, so usually only components containing harmful substances are removed. After dismantling in a semi-automatic process, components made from metal such as cables and motors are recovered
Entertainment equipment	400	22.2%	Televisions, monitors, video recorders, radios	• Video equipment such as televisions and personal computer monitors account for around 80% (320,000 metric tons) of the total • The bulk and weight of television-type equipment give it an extremely high weighting in the recycling system • As noted above under small consumer equipment, a large part of small entertainment equipment such as radios and video recorders is disposed of as household waste. Much of the recycling work consists of manual dismantling, the cost of which is made high by the wide range of equipment types. It is therefore difficult to cover costs through selling the recovered resources. This is influencing the rise in plastic-usage volume in such equipment
IT equipment	110	6.1%	Computers, peripherals	• The category showing the fastest rate of expansion, expected to at least triple the current level in the medium term • 30,000 metric tons from consumers, 80,000 tons from businesses • Higher weighting of metal than entertainment equipment, so recycling economical. Demand for used components also rising. Recycling of PCB substrates containing precious metal and harmful substances a key factor
Office equipment	110	6.1%	Copiers, printers, game platforms	• Copiers have highest weighting (31,000 tons), with disposal of selenium-containing drums an important point • Often handled by specialist re-use businesses, so high recovery rate and much recycling of used components
Communications equipment	140	7.8%	Telephones, faxes	• Like IT equipment, showing marked expansion • Like IT equipment, usage life is relatively short, so possible to incorporate ease-of-disassembly and other advantages in the design and production process • Supply from businesses easily sufficient, but insufficient from consumers. In particular, harmful substances contained in batteries pose a major problem if cellular telephones are disposed of mixed with household waste
Industrial equipment	360	20.0%	Motors, welding equipment	• More economical recycling compared to consumer equipment possible because 1) collection can be organised efficiently, 2) high metal weighting • Easy to recycle because less harmful substances than contained in consumer equipment
Medical equipment	50	2.8%	X-ray equipment, dental equipment, measuring equipment	• Specialist knowledge required, especially for X-ray equipment and radiotherapy equipment (10,000 tons) • Economical to recycle because of average metal weighting of 70% • High sufficiency rate in large and medium equipment, but lack of reliable and comprehensive collection system for small equipment
Total	1,800	100.0%		• From consumers: 1,100,000 tons, from businesses: 700,000 tons

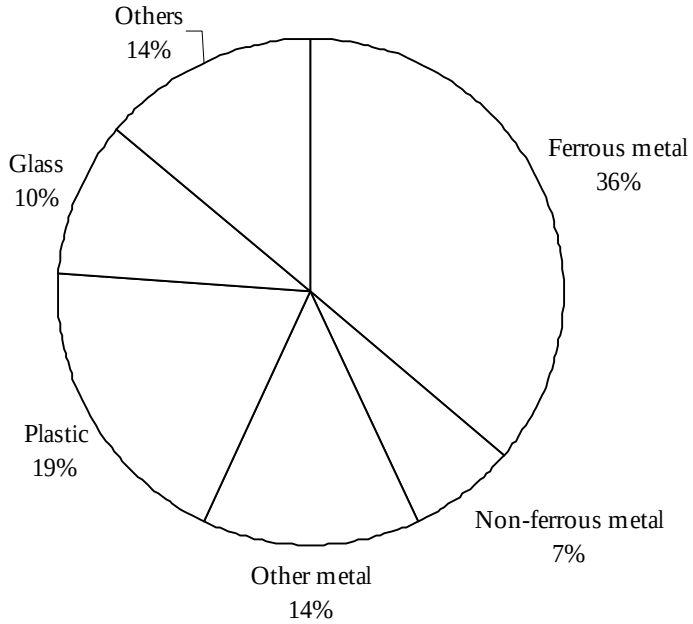
Source: Prepared from *Elektronikschrottrecycling Fakten, Zahlen und Verfahren*, bvse.

Figure 3-11. WEEE in the EU and Germany



Source: Elektronikschrottrecycling, bvse.

Figure 3-12. Breakdown of Materials in WEEE



Source: Prepared from *Elektronikschrottrecycling Fakten, Zahlen und Verfahren*, bvse.

As shown in Figure 3-12, WEEE is composed of a variety of resources. The desirability of promoting efficient re-use of these was a major incentive for new regulation, together with others including:

1) The need to stop WEEE being transported to incineration and final disposal facilities mixed in with household waste, because of the harmful substances contained in them such as lead, cadmium, and bromine-type flame retardant
2) The need to reduce the weighting of WEEE being exported, despite the Cyclical Economy and Waste Law's banning of the export of substances harmful to the environment

A further objective is to avoid pushing up the total costs of recycling such as fee procurement costs, which is anticipated if widening the scope of targeted equipment results in detailed regulations for each category that divide the market into smaller and smaller segments. Figure 3-13 shows the disposal process for equipment currently covered by the recycling system. The aim of new regulation is to increase dramatically the ratio of equipment entering the 'appropriate disposal' system displayed here.

However, the introduction of new regulation has not made smooth progress. The debate on new regulation started in 1991 with the draft legislation produced by the Federal Environment Ministry concerning restricting and reducing the generation of WEEE, and its recycling. According to the draft, manufacturers and sellers were to collect WEEE free of charge and recycle it, only disposing as waste the un-recyclable or partially un-recyclable parts. The law was originally scheduled to be promulgated in January 1994, but disputes over matters such as the scope of responsibility, and the role and costs to be borne by each party, caused postponement.

To try to resolve the situation, the government submitted draft legislation just covering IT equipment[23] in May 1998. This passed the Federal Lower House, but the revisions shown in Figure 3-14 were proposed by the Upper House in June 1996, and the debate on these has continued since. The revisions would constitute a return to the wide range of WEEE targeted since 1991. In the meantime, the external situation has changed with, for example, the EU's WEEE Directive Proposal discussed above, and it remains to be seen how German WEEE regulations finally turn out.

Figure 3-15 is a comparison of German draft legislation seen so far, and the EU's WEEE Directive Proposal. Many areas of German proposals are likely to be changed to match the directive proposal, such as inclusion of extra types of equipment, and collection and recycling rates, but the most significant feature of the plan is that local authorities will carry out collection. This presumably results from the judgement that a national collection system is needed, because of the wide range of equipment, with a variety of disposal methods, being targeted. It should be noted the responsibility of local authorities is limited to providing a close interface with the discarders, such as collection sites[24]. For example, when sorting and intermediate processing are required, manufacturers must bear the cost. Nevertheless, of significance is the need to change the system design according to the characteristics of the items for recycling, that is implied by this divergence[25] from the fully private-sector system introduced by the Packaging Materials Ordinance, against which all German recycling policies should be compared.

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[23] Full title: 'Ordinance for Appropriate Disposal of Information, Office, and Communications Technology Equipment' (Verordnung uber die Entsorgung von Geraten der Informations-, Buro-, und Kommunikationstechnik), commonly known as the 'IT Equipment Ordinance'.

[24] It is also noteworthy that in accordance with local government public tax regulations, commissions are charged on waste processing carried out by local authorities.

[25] The phrase 'shared responsibility' (geteilte Verantwortung) is used in the case of WEEE. In this case, in principle local authorities and collection operators commissioned by them are responsible for collection, while manufacturers are responsible for all stages beyond collection. This division of responsibility differs from the Japanese home appliance recycling scheme.

Figure 3-13. The Course of Development of WEEE Processing in Germany, and Points of Contention

Removal of harmful substances (Schadstoffentfrachtung)

Examples of components to be removed	Harmful substance	
Condensers	PCB	Technological Guidelines on Specially Administered Waste
Batteries	Heavy metal	Waste Battery Ordinance
Mercury-containing switches and relays	Mercury	
Liquid crystal displays	-	Technological Guidelines on Specially Administered Waste
Old hairdryers, toasters, etc.	Asbestos	
Cathode ray tubes	Heavy metal	
CFCs used in refrigerators	CFCs	
Fluorescent lighting	Mercury	

Prior dismantling (by hand) (Vordemontage)

Separation of:
Recyclable components Components made of one element that do not require a divided-stage process to remove Items remaining after dismantling by an automatic divided-stage process
However, processing of medical and other kinds of equipment to be carried out by specialist operators

Recycling and processing (Recycling, Trennen)

(Main points of contention)

- Recovery of ferrous and non-ferrous metal
  ⇒ Traditional recycling area. Recycling rate of 95% or higher of collection volume achieved in WEEE
- Recovery of metal from cables
  ⇒ Processing to remove ferrous metal, aluminium, and other metal from electricity-transmission and other cables; the process is economic with no major problems
- Recycling of fluorescent lighting
  ⇒ Annual waste volume of 26,000 tons; processing to recycle the small quantities of mercury contained. Air is injected to remove the fluorescent materials and mercury, which are then filtered out. Metals and glass are fragmented and recovered in the usual way
- Recycling of plastic
  ⇒ An extremely large number of different types of plastic are used in equipment currently being recycled. These are generally categorised into 1) combustible, 2) non-combustible (containing flame retardant), and 3) hardened plastic, but in each category sorting by type is necessary for material recycling. Methods include grinding up and grading, but many problems exist, including the fact that the process is uneconomic except for some extremely valuable types
- Separation of glass
  ⇒ Together with plastic, glass commands the highest weighting in WEEE. The main process is separation of the glass contained in many components into types. Future challenges include development of the technology for economic recycling of masks removed from panel guards, and standardisation to promote material recycling of glass
- Processing of mixed metal/plastic units
  ⇒ Technology needs to be developed for low-cost processing of components made of multiple materials, and containing few valuable materials
- Processing of printed circuit boards
  ⇒ This area has seen a marked increase (1998: 100,000 tons) as the volume of waste personal computers has grown. Although the boards contain precious metal such as platinum and gold, they also contain harmful substances such as bromine-type flame retardant, so combining recovery with guarding against harm is extremely expensive. Therefore the following processing pattern is being used, while new technology is being developed:

  Removal of parts containing harmful substances and re-usable parts
  - Precious metal recovered by refining if present
  - Separation of metal and plastic in dry process after shredding if little precious metal present

- Processing of condensers ⇒ Classified as Specially Administered Waste, so processed in special waste incineration facilities or by underground disposal
- Processing of batteries ⇒ Cost reduced sharply by introduction of automatic sorting facilities. Low collection rate a problem, but 1998 Waste Battery Ordinance expected to bring improvement
- Processing of CFCs used in refrigerators

etc.

Source: Prepared from *Elektronikschrottrecycling*, bvse.

Figure 3-14. Revisions Proposed by the Federal Upper House

- Scope of application
  Regulations to be broadened to cover amusement equipment and home appliances. Accordingly most of the 1.5 million tons of WEEE would be covered, not just the 10% represented by IT equipment
- Collection obligations
  Manufacturers compelled to collect not just their own brand goods, but other brands in the same category, and equipment existing in the market before the regulations take effect. Obligation limited to volume sold per calendar year
- Local government responsibilities
  Local authorities are still to carry out collection of WEEE discarded by consumers, but not for processing themselves, rather in order that the manufacturers and the recycling system can receive the goods. However, discussion continues on who is to bear the associated new costs of containers, sites, etc.

Source: Federal Environment Ministry's web site.

Figure 3-15. Comparison of the EU's WEEE Directive Proposal and German Draft Legislation

	WEEE directive proposal (EU)	German draft WEEE legislation
Targeted waste (annual waste volume)	Electrical and electronic equipment (8 million tons per year)	Electrical and electronic equipment (2 million tons per year)
Objective	Restriction of waste, re-use, recycling (targets set)	Restriction of waste, re-use, recycling (no targets set)
Product requirements	• Banning of use of substances (by 2008) • Reduction of use of plastics • Code number regulations for components and materials • Capable of being repaired, adapted, re-used, dismantled, and recycled • Recycled plastic usage rate of 5% (by 2004)	None
Seller requirements	None	• Compelled to accept same kinds of equipment as those sold
Cost allocation	• Member states to decide who bears cost of collection • Manufacturers to bear cost of recycling new products • Five-year interim measures for products sold in the past	• Local authorities to bear cost of collection • Manufacturers to bear cost of sorting and intermediate processing, etc. conducted by local authorities • Manufacturers to bear cost of recycling and processing
Limitations	Five-year interim measures	Manufacturers only have to handle the same unit volume as their sales that fiscal year
Collection	• Member states to decide themselves	• Local authorities compelled to collect • Manufacturers may also set up their own collection systems
Collection rate	• Target: Average 4kg per person annually • Minimum level: To be decided from 2006	None
Recycling rate (volume base)	• Large home appliances: At least 75% • Small home appliances: At least 50% • Gas discharge lighting: At least 80% • Equipment using cathode ray tubes: At least 70% etc.	None

Source: Prepared from Elektro- und Elektronikschrottrecycling, bvse.

2.4 The Current State of the German WEEE Recycling Industry

Delays in the introduction of new legislation have had a major impact on waste processing businesses. Environment-related businesses are generally very sensitive to regulatory trends, since their markets are created by new and revised regulations, and the WEEE recycling sector is no exception. In the past dominated by medium and small operators, the signs that new regulations were on the way in the early 1990s prompted a succession of new entrants, especially from energy divisions of large corporations, resulting in a process of oligopolisation.[26]

Many existing operators, let alone the new entrants, have been looking to increase their capacity, seeing a good business opportunity in a processing volume of over one million tons annually, stable processing fees, the proceeds from selling components, recovered materials, and so on. However, delays in the passage of legislation so far have kept down the volume of waste equipment entering the system[27], leading to increased price competition to secure sufficient volume, so that now operating base closures and personnel adjustments have become a threat in the industry.

The course of development of WEEE recycling in Germany provides a useful illustration of system design problems, and above all, of different approaches to collection systems. There are also implications relevant to Japan to be drawn from the problems of not securing sufficient volume entering the system once it is operational, due to legislative delays or other reasons.

[26] The informative RWI survey (75 replies from 262 companies surveyed) mentioned earlier shows that as of 1996 the top ten companies controlled 66.3% of sales, 69% of processing volume, and 64.2% of employment, with the top 25 companies controlling 86.2%, 87%, and 83.4% respectively.

[27] Compared to the initial forecast as of 1996 of 1.5 million tons, only around 460,000 tons of waste equipment is apparently being processed by the private-sector system. According to the RWI survey, around half of the number of items being processed came through the local government collection system, followed by the retail sector and corporations. Collection from consumers is very limited, and the survey concludes: 'People and institutions using electrical and electronic equipment rarely consider disposal and recycling of the equipment after its use has ended'. This illustrates the difficulty of trying to set up the recycling of electrical and electronic equipment, especially small items that are easy to discard.

IV. Towards the Use of Recycling Infrastructure

1. Towards Revision in Five years

The introduction of a full-scale PCW recycling system for home appliances in Japan faces a number of challenges at its inception. It will be some time after the system has started operation before it can be properly appraised, since there are volitional components to the special division of responsibility system regarding the handling of the specified home appliances, and because the re-commercialisation rates exclude reverse-payment arrangements with a view to efficient use of resources, and so on. The government also intends to review the situation after the scheme has been in operation for five years, and then carry out such measures as may be necessary. This chapter will examine areas where revisions may become necessary, in the light of controversial points summarised so far, overseas trends, and so on. This could be done from a number of approaches, but we intend to tackle the subject with respect to how profitability and stable operation of recycling facilities can be achieved.

2. The Challenges of Maintaining and Raising Operating Rates

2.1 Problems in Defining Waste Goods

In order to maintain appropriate plant operating rates and secure their long-term profitability, as many as possible of the four types of home appliance currently being targeted must enter the system, and the resource recovery rate from the waste home appliances collected must be raised.

A manifest administration system is built into the scheme to track the appliances once they have entered it, so presumably the majority of such appliances will actually reach the processing stage (ignoring the problems of extra efforts needed to control this and to prevent stealing from depots and such). The challenge faced is therefore the portion of waste home appliances that do not enter the scheme, and are instead processed (or discarded) in other ways. Of course, the most important consideration is therefore to ensure that the discarders, i.e. consumers, are fully informed of the new system. The administrators of the scheme have already started this diffusion and education exercise, but it would be more efficient in this case of where costs are not internalised (not included in product prices) if the charge to consumers were lower, thus reducing the temptation not to use the scheme. Reduction of the scheme's charges may be assisted by technological innovation that improves the profitability per weight unit of the collected appliances, as described below, but this looks unlikely for the being, since the declared charges seem to reflect more what consumers are thought to be willing to pay, than the prime cost of processing.

At present it would therefore probably be more efficient to reduce such costs incurred in carrying out recycling business as can be reduced. Above all, if revision of the system is to be considered, reduction of costs arising from the system's design should be examined. The fundamental costs arising from the Waste Disposal Law's strictures on waste home appliances are a prime example of what we mean by costs arising from the system's design.

As described in Chapter 1, by its nature the Home Appliance Recycling Law is secondary legislation appended to the Waste Disposal Law. In other words used home appliances have been defined as waste[28]. Of course, in order to carry out collection, transportation and processing of

[28] In Japan waste is defined by the Waste Disposal Law, and by notification from the former Ministry of Health and Welfare pertaining to that law, namely things no longer wanted by the possessor, which cannot be sold for payment to others, in other words articles with no usage or exchange value. Accordingly, this raises problems such as needing permission to process used home appliances due to their classification as waste. For further economic interpretation of waste, see Yoshino [1996].

waste, the permission of the municipality's mayor or equivalent is required for household waste, and the permission of the prefecture's governor or equivalent is required for industrial waste. One exemption from the Waste Disposal Law enshrined in the Home Appliance Recycling Law is the waiving of the requirement for parties who have in the past manufactured or imported specified home appliances themselves to obtain such permission for processing (including processing contracted to other parties) those appliances (Section 49). However, in order to maintain facility operating rates, it will be necessary to process home appliances manufactured or imported by other parties, and items outside of the four categories. In this case it will be necessary to obtain new consumer and industrial waste processing licences, both of which are becoming harder to obtain. Consequently, makers have been forming tie-ups with operators who already hold licences in the relevant fields, in order to surmount this problem. Such prior preparation has been going on in every region, and the costs of maintaining and administering such networks over the long term will probably be significant. Such costs also add to processing prime cost. Together with the problems of obtaining permission for recycling facilities from town planning councils, this is an area where improvement is desirable[29], and can be regarded as stemming from the legal treatment of used home appliances as waste.

Used home appliances have no usage or exchange value for the discarding consumer, which enables them to be regarded categorically as waste. However, value is then generated during the course of the dismantling and separation processes. It is because the Japanese legal system regards such goods as waste that the above problems are caused.

Rather than being a shortcoming of the Home Appliance Recycling Law, this is a bigger problem stemming from the definition of waste. The German Cyclical Economy and Waste Law changed the definition of waste to distinguish between waste which can be efficiently re-used and waste which should be disposed of, with the former targeted for return to the economic system as a form of secondary raw material. In the same way, Japan should also consider legal redefinition of waste.

The Ministry of the Environment has already declared its intention to revise the categorisation of consumer and industrial waste as part of its deregulation activities. Furthermore, in January 2001 a think-tank calling itself the Waste in the 21st Century Discussion Group proposed changing the definition of waste to distinguish between 'waste' and 'useful goods (valuable goods + valueless goods)' and thus exclude recyclable goods from the regulatory system of the Waste Disposal Law. The subject is therefore expected to be discussed in greater detail henceforth.

Moreover, widening of the range of appliances to be processed is an important step towards raising operating rates, but this will be discussed below.

A trend towards development of easily-recyclable products has already begun, aimed at raising resources recovery rates. Figure 4-1 summarises examples that have emerged so far. A number of different approaches are in evidence, including restriction of materials, and the increased use of one-piece units to make dismantling easier. There has also been related development in measures against harmful substances, with Japanese corporations leading the field in avoiding the use of lead in particular. This is a prime example of the merits of EPR, i.e. extension of the responsibilities of the parties who know the most about the products - their manufacturers. This trend is expected to accelerate in the future as information feeds back to the manufacturers from their recycling operations. This also reflects progress in advancing LCA-type methods.

[29] See Hosoda [2000].

Figure 4-1. Methods of Making Home Appliance Easier to Recycle

All appliances	•Restriction of plastic grades •Revision of plastic composition •Indication of plastics used
Televisions	•Switch to halogen-free flame retardant in main units and printed circuit boards •Reduction of number of components through integration of printed circuit boards, etc. •Use of lead-free cables
Refrigerators	•Reduction of number of screws used through structural improvement •Shortening of PVC-sheathed cables, elimination of PVC door sashes •Use of lead-free, halogen-free printed circuit boards
Washing machines	•Unification of dismantling procedures •Separation of motor made easier through structural improvement •Use of lead-free printed circuit boards
Air conditioners	•Reduction of hard-to-recycle components and materials •Reduction of number of screws used through fewer components, etc. •Switch to coatings using resinous materials

Source: Various corporate environmental reports and other reports.

2.2 The Introduction of 'Recycling Rates'

Changes to the current re-commercialisation rates are also expected when the Home Appliance Recycling Law is revised five years hence. Once again, it should be borne in mind that Japanese re-commercialisation rates for the four categories of home appliances do not include 'reverse-payment' disposal, unlike corresponding rates applied in Europe. If the current recycling rates are revised upwards, recycling of plastic parts will become mandatory, in addition to raising of the recovery rates of materials already covered such as metal and glass. These challenges should be partly resolved through technological innovation making recycling easier, but it is unlikely that most of the plastic composition of products can be processed whether through paid or unpaid methods.

According to figures produced by the Association for the Promotion of Plastic Disposal, in 1998 waste plastic from both consumer and industrial sources reached 9.84 million tons, of which 33% or 3.28 million tons was buried as landfill. Around 44% is now being recycled, either via incineration to generate electricity or heat, or through material recycling, and this ratio is expected to rise in the future.

There are diverse methods of recycling plastic, among which use in blast furnaces looks extremely promising. Blast furnaces work by feeding iron ore and coke in turn into the top, while hot air is blown in through the tuyere at the bottom. The coke is converted into CO gas, with the heat generated in this reaction and the CO causing reduction and melting of the ore. The pig iron and slag thus generated are then drawn off from the bottom of the furnace. Plastic can be used in blast furnaces as a reducing agent to replace the coke (up to around 40%). Blast furnace operators are currently believed to be targeting the use of 200,000-300,000 tons of plastic per year in this way. The advantages of using waste plastic as a reducing agent in blast furnaces include:

1) Large volumes can be processed
2) Many types and kinds of plastics can be used, including compound plastics
3) Usage efficiency is high
4) No dioxin is generated

Of the 106,000 tons of 'other plastic' to be processed according to the Container and Packaging Recycling Law which came into full force in April 2000, 40% is to be used in blast

furnaces. As this shows, blast furnaces are a very promising recycling method.

As with used home appliances then, there are problems that need to be resolved like bromine-type flame retardant contained in television main units and elsewhere. However, since appliances with high plastic composition weightings are likely to be added to the range of targeted goods, processing of waste plastic in blast furnaces remains a promising option. In fact, Mitsubishi Electric has already announced its intention to introduce equipment to sort plastic from used home appliances and enable its use as a reducing agent in blast furnaces.

However, the re-commercialisation rate presents a problem. At present only goods which can be passed on in return for payment or for free are regarded as being recycled. However, when commissioning blast furnace operators to process waste plastic, payments will have to be made to the blast furnace operators for their processing costs, which will constitute non-permitted 'reverse payments'. Reverse payments are probably not permitted because of the contrast with marketable goods enshrined in the current legal definition of waste. Whatever the reason, under the current framework blast furnace processing will only be considered as re-commercialisation if the waste plastic can be sold to the blast furnace operators as a coke substitute. This reverse-payment problem looks difficult to resolve in the near term, since the volume of plastic collected is unstable, there are quality complications making necessary capital investment on prior sorting processes and so on to remove impurities. In the long term, of course, it is quite feasible that blast furnace operators will be able to receive a stable supply of an appropriate volume of thoroughly sorted waste plastic, as recycling systems for containers and packaging and so on get into their stride. But the present situation means that although blast furnace processing is an appropriate recycling method for plastic, it will do nothing to boost the re-commercialisation rates of used home appliances.

A recycling rate that permits both re-commercialisation and recycling rates including reverse-payment arrangements is therefore desirable. This would allow processing methods such as blast furnaces that are appropriate despite involving reverse payments, to live up to the ambitious intentions of the Home Appliance Recycling Law, and make possible recycling rates comparable to those in Europe.

3. Problems in Expanding the Scope of Targeted Appliances

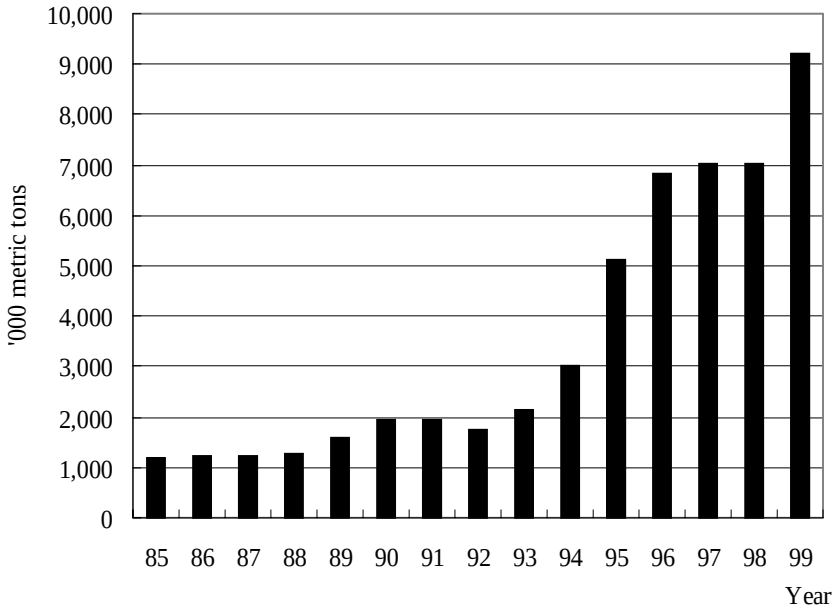
Extra targeted appliances will need to be added to the four categories in order to achieve stable operation of recycling facilities. There are many possible candidates just within home appliances, such as video recorders and microwave ovens. However, these are easily portable and therefore quite different to the existing four categories, collection of which will generally be carried out by retailers. This raises doubts as to whether such new categories will accord with the spirit of 'Specified Home Appliances' enshrined in the law. Being easily portable, unlawful discarding will also be simple to carry out. Many of these goods also have a high composition weighting of hard-to-recycle plastic, and re-commercialisation rates will be a thorny issue. Targeting of new appliances and additional efficient collection systems will be two tasks to be considered when revising the Home Appliance Recycling Law.

IT equipment such as personal computers and cellular telephones will present considerable problems as additional recycling targets. Such problems will probably be as big as or even bigger than those posed by the existing four categories of home appliances, since IT equipment is diffusing rapidly and becomes obsolete very fast.

Figure 4-2 shows domestic personal computer shipment volume. The launch of Windows 95 caused a big surge in diffusion, which combined with the short life of the products means a large volume of waste personal computers is expected in the future. The Electronic Information Technology Industry Association estimates that 45,000 tons of waste personal computers were

generated in fiscal 1998, of which 37,000 tons came from businesses and 8,000 tons from consumers. The association expects volume to expand up to 2001, and then to fluctuate around the 80,000 tons level over the long term, due to decline in per unit weight.

Figure 4-2. Domestic Personal Computer Shipment Volume (Main Unit)



Source: Japan Association for the Promotion of Electronic Industries.

The same is true for cellular telephones and PHS terminals. Aggregate subscriber contracts for the two types of equipment have already passed 50 million, so a large volume of waste handsets is being generated.

A processing scheme for these kinds of IT equipment is already being set up under the Law for the Promotion of Efficient Utilisation of Resources, which has a wider scope than the Home Appliance Recycling Law. This law was enacted in July 2000 through revision of the Law for the Promotion of Utilisation of Recycled Resources (the former Recycling Law). It is scheduled for enactment in April 2001 and obliges businesses to carry out the so-called 3R's for specified products: restriction of waste generation, re-use of components and so on, and recovery and recycling of used products. Since the time of the previous law, personal computers had been under consideration as targets for recycling, and in June 2000 the Waste and Recycling Section of the Industrial Structure Council in principle decided to target them in the new law. As a result, the Ministerial ordinance draft promulgated in January 2001 sets the following used-product minimum recovery and recycling limits that must be achieved by personal computer manufacturers by fiscal 2003: desktop models 50% (excluding displays), notebook models 20%, cathode ray tube displays 55%, liquid crystal displays 55%.

The Ministerial ordinance draft also proposes the targeting of nickel-cadmium and other kinds of rechargeable batteries[30]. This measure follows the lead taken by the German Waste Battery Ordinance, and is designed to establish a scheme for appropriate recovery, recycling, and

[30] The majority of rechargeable batteries are sold already installed in appliances.

disposal in consideration of the harmful substances and so on contained in rechargeable batteries. Such regulation will also have a major impact on the recycling of used cellular and PHS telephones. When batteries currently in use are replaced, the old batteries will be collected[31], and control of used equipment using rechargeable batteries will be tightened, thus reducing the volume that is included with normal household waste, and making it easier to collect used batteries in large quantities. Thirteen battery makers have already established the Japan Battery Recycling Association targeting the collection and recycling of small rechargeable batteries, and they are encouraging the makers of equipment containing rechargeable batteries to take part, among other developments.

Some makers have been preparing the infrastructure for personal computer recycling in anticipation of such anticipated regulation. An outline of these developments is shown in Figure 4-3. The channels and infrastructure for paid collection and recycling of used computers from corporate sources, which have a higher weighting than consumer sources, were prepared originally, so makers are now concentrating on the same kind of infrastructure for collecting from consumer sources, which will also become compulsory in 2002. There is also now a new trend towards product development based on LCA analysis, and the design and launching of easily recyclable products.

Figure 4-3. Personal Computer Recycling Trends

	Infrastructure	Collection system	Adaptation to consumer sources
NEC	Recycling bases: 5; Collection bases: 14 (scheduled to increase in 2001) Component re-use entrusted to subsidiaries	NEC Logistics and collaborating logistics operators	Use of household delivery services under consideration
Fujitsu	Recycling bases: 5 Collection bases: 13	Fujitsu Logistics and collaborating logistics operators	Development of existing collection system
IBM Japan	Recycling bases: 3 Collection bases: 12 (gradual conversion of parts centres)	Logistics subsidiaries and collaborating logistics operators	Use of household delivery services under consideration; Joint development of Internet based collection system
Hitachi	Collection bases: 3 new facilities → two company total of 15 to be used jointly	Hitachi Logistics and collaborating logistics operators	

Note: Some recycling and collection bases are joint facilities.
Source: Company web sites and various reports.

The different schemes for home appliances and personal computers stem from personal computers having a different sales pattern, and their rapid product turnover meaning that they can be re-used in many cases. Corporations are the main users of personal computers, and lease contracts are the norm, providing stable collection conditions. Consequently, it is reasonable to judge that the system of shared responsibility between producers, sellers, and consumers that has been prepared for the four categories of home appliances should not be applied to personal computers. However, this method of selecting certain types of equipment as suitable for recycling, and then setting up the infrastructure, means that some types of equipment will be excluded. Furthermore, setting up of different infrastructure for each type of equipment raises doubts as to whether appropriate plant operating rates can be achieved. The process to be

[31] For example, NTT DoCoMo has been collecting used batteries since 1993, and used terminals and other equipment since 1998, achieving collection of 5.05 million units in 1998, and 5.90 million in 1999.

applied to personal computers, for example, of dismantling and sorting → fragmentation and sorting → resource recovery → disposal, is similar to that for televisions and other home appliances. Moreover, the current diffusion of 'IT home appliances' means that home appliances are rapidly becoming more similar to personal computers in their functionality. In these circumstances, is it sensible to set up different systems at the infrastructure level of processing plants and so on, let alone at the collection stage? As mentioned previously, the European WEEE category is likely to become the *de jure* standard, and this category encompasses both home appliances and IT-related equipment.

A policy of sub-dividing targeted equipment and setting up different schemes would invite problems such as exclusion of some kinds of equipment, and insufficient operating rates in categories where sufficient waste volume cannot be secured. As a result, it also risks raising total costs (including social costs). When the Home Appliance Recycling Law is revised, integration with IT-related equipment recycling schemes should be considered.

It is hoped that the planned revisions to the Home Appliance Recycling Law will resolve the problems outlined above, so that the scheme's infrastructure can develop to handle all common forms of PCW.

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References

Atsuhiko Sano, Kayoko Nanata. 2000. *Kakudai suru Kigyo no Kankyo Sekinin (Increasing private-sector responsibility for the environment).*

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit 2000. *Umweltpolitik Umweltgutachten 2000 des Rates von Sachversändigen für Umweltfragen*. BUM.

bvse 1999. *Elektronikschrott Recycling Fakten, Zahlen und Verfahren*. bvse.

bvse 2000. *Geschäftsbericht 1999/2000.* bvse.

Ecobusiness Network 2000. *E de Mitewakaru Recycle Jiten* (*Pictorial Recycling Dictionary).* Japan Plant Maintenance Association.

Eiji Hosoda. 2000. *Yokuwakaru Kaden Reycle-Ho* (*Understanding the Home Appliance Recycling Law).* Nikkei Ecology, May 2000, etc.

Iwao Omae. 2000. *Plastic Recycle wo Dosuruka* (*What To Do About Plastic Recycling?)* Chemical Industry Daily.

Jacqueline M. Bloemhot-Ruwaard, Moritz Fleischmann, Jo A.E.E. van Nunen 2000. *Previewing Distribution Issues in Reverse Logistics, New Trends in Distribution Logistics.* Springer.

Japan Association for the Promotion of Electronic Industries [all issues]. *Shiyozumi Computer no Kaishu/Shori/Recycle no Jyokyo ni Kansuru Chosa Hokokusho* (*Survey of Used Computer Collection, Disposal, and Recycling*).

Katsuya Nagata (Editor) 1996. *Seihin Assessment to Recycle Sekkei Jirei* (*Product Assessment and Recycling Design Examples).* Clean Japan Center.

Kazuhiro Ueda. 1992. *Haikibutsu to Recycle no Keizaigaku* (*The Economics of Waste and Recycling*). Yuhikaku.

Kunihiko Takeda. 2000. *Recycle Osen Retto* (*Recycling the Polluted Peninsular).* Seishun Publishing.

Makoto Ando. 2000. *Ho-kisei ga umu Business Chance* (*Business Opportunities from Legislation).* Environmental Equipment, December 2000.

Marianne von Halstrick-Schwenk 2000. *Umfang und Struktur der Entsorgungswirtschaft im Bereich Elektroaltgreäte/Elektronikschrott in Deutschland.* RWI-Papiere, Nr.65.

Ministry of International Trade and Industry, Machinery Industry Office, Electrical Machinery Section 1999. *Kaden Recycle-Ho no Kaisetsu* (*Explanation of the Home Appliance Recycling Law).* International Trade and Industry Research Society Publishing Section.

O Sokupiru. 1999. *Kankyo Seisaku no Keizai Bunseki* (*Economic Analysis of Environmental Policy).* Japan Economic Appraisal.

Shusaku Yamatani (Editor) 2000. *Haikibutsu to Recycle no Kokyo Seisaku* (*Public Policy on Waste and Recycling).* Chuo Keizai.

Toshiyuki Yoshino. 1996. *Shigen Kankyo-gata Shakai no Keizairiron* (*Economic Theory of a Resource Cycling Society).* Tokai University Press.

Tsuneo Matsumura. 2001. "*Shiyozumi Kadenhin no Recycle System* (*The Used Home Appliance Recycling System)". Keisoku to Seigyo (Measurement and Control),* Volume **40**, 2.

Yasushi Umeda (Editor) 1998. *Inverse Manufacturing.* Industrial Research Association.

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