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Assessing Extended Producer Responsibility LAWS *in* JAPAN

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A major computer chain store sells secondhand computers, computer parts, and digital equipment (e.g., digital cameras, DVD players) along with new products in Shinjuku, Tokyo.

Take-back legislation provides an incentive for producers to incorporate environmental considerations into product design and to shift the responsibility for end-of-life products away from municipalities.

Production and consumption of mass-manufactured goods have been the driving forces of Japan's economy during the past several decades. In recent years, however, Japanese society has run into numerous environmental constraints: increasingly scarce landfill sites, concerns about disposal of toxic wastes, hazardous emissions from waste-management facilities, and high dependence on imports of raw materials. Public concern about environmental quality and waste-management practices has also been raised by several high-profile controversies. For example, anxiety over dioxin and other hazardous emissions from waste incinerators that are a primary method of municipal solid-waste disposal led to the adoption of the Law Concerning Special Measures against Dioxins in 1999. This legislation called for a 90% reduction in dioxin emissions by 2003 (*1*). The issue of waste disposal became increasingly prominent on the Japanese political agenda in the mid-to-late 1990s and culminated in the adoption of new laws aimed at safer and more effective waste management.

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Central to the Japanese approach is the use of extended producer responsibility (EPR) in the form of producer "take-back" legislation. The twin objectives of EPR are to provide an incentive for producers to incorporate environmental considerations into product design, and to shift the responsibility for end-of-life products (physically or financially, or both) upstream to the producer and away from municipalities. During the past decade, take-back legislation has been widely incorporated into Japanese environmental regulations as well as those in other jurisdictions, most notably the EU. Here, we provide an overview of the operation and efficacy of Japanese EPR laws that are related to manufactured goods (i.e., computers, home appliances, and automobiles) and present some lessons learned.

Japan's new waste-management paradigm

In 2001, Japan adopted a new legal framework to promote social and technological changes toward establishing a sound material-cycle society in which resources are more effectively used by following the "3Rs" (reduce, reuse, recycle) principle. Three basic laws set the legal structure, the responsibilities of entities, and the industries and projects covered by the new legal framework. In addition, the legal framework includes five laws specifically aimed at sectors and products. These are designed in accordance with characteristics of products, industry structure, market, and recovery infrastructure, and they are based on the principle of EPR (Table 1).

In Japan, EPR is compatible with the shared-responsibility principle. Citizens, businesses, municipalities, and the national government each bear a portion of the burden and have clearly defined responsibilities. For example, under the Home Appliance Recycling Law (HARL), retailers collect end-of-life products, consumers pay the expenses mandated for recycling and transportation, and producers recycle the collected products. Figure 1 shows how post-use burden is distributed among stakeholders under HARL. Most EPR laws in Japan require consumers to pay a portion of the expenses required for recycling and transportation. The recycling fee is $23–44 (at the exchange rate of $1 = ¥110). Additional fees include a transportation fee of $4–18 for home appliances, $29–38 for computers and monitors, and $55–164 for automobiles (*2*–*4*). Costs of recycling are collected at the time of purchase for new computers and automobiles, during regular inspection for automobiles sold before the law, and at disposal for home appliances.

Assessing the success of Japanese EPR laws

One way to measure the success of Japanese EPR policy is to compare the actual recovery rates with numerical targets mandated by law. Under Japanese EPR laws, numerical targets have been set for recovery rates of home appliances, food waste, computers, rechargeable batteries, construction waste, and end-of-life vehicles (ELVs). Some laws set a timetable for achieving targets (food waste, construction waste, and ELVs), whereas others have no set timetable but are subject to periodic review (home appliances, computers, and batteries). Table 2 shows actual recovery rates of regulated products and targets defined by the laws. Recovery rate is broadly defined as recycled mass (including reuse and energy recovery) divided by collected mass of products. Specific definitions of recovery rate vary from product to product as detailed in Table 2. The data show that actual recovery rates have met or exceeded regulatory standards or targets for most products. In some cases, such as for home appliances, food waste, and computers, recycling rates far exceed mandated standards and targets. The reasons for this differ from product to product. Standards for home appliances were set in the late 1980s and early 1990s on the basis of metal composition, recovery efficiency, and lifetime of products, and they incorporated recovery efficiencies and recycling rates for plastics from an earlier and less technically advanced era. Consequently, standards for recycling of appliances are lower than what can currently be achieved and hence are easily met.

Recovery rates for manufactured goods are relative to goods that have been collected and not all

Technological innovation under EPR in Japan

Technological innovation has contributed to an increased level of recycling under the EPR laws in Japan. The key to increasing the recycling rate of automobile shredding residue (ASR) is recycling plastic. Automobile manufacturers now use recyclable thermoplastics and one type of plastic instead of composite materials. Design for disassembly, marking for identification of materials, and reduction of hazardous substances are being pursued by automobile and appliance manufacturers with some success. In 2005, four models of Nissan vehicles, including Note and Serena, achieved a possible recovery rate of 95%—the highest level in the industry (*20*).

Innovation is not limited to the auto sector. At Mitsubishi Electric, for example, 2005 models of air conditioners and refrigerators improved performance per unit environmental impact (material, energy, and toxicity) by a factor of >2 (*21*). The Matsushita Eco Technology Center (METEC), which began operations in 2001, the same year HARL took effect, has filed 68 patent applications, including the high-speed separation of cathode ray tubes (CRTs), normal-temperature crushing of compressors, high-grade separation of copper and aluminium from heat exchangers, and the whirlpool sorting of blended plastics (*22*). At METEC, plastic parts used in home appliances are increasingly being recycled into new parts, saving raw materials and reducing waste.

At an organizational level, the Japanese approach involves the formation of competing consortia. Japanese vehicle manufacturers collaborating on the improvement of ASR recycling have formed two consortia. One team is made up of Toyota, Honda, and six others, and the ASR recycling promotion team consists of Nissan, Mazda, Mitsubishi, and nine others. Both teams conduct R&D on ASR recycling technology while managing the recycling of the ELV streams by using outsourced recyclers. In response to HARL, appliance manufacturers have also formed two consortia, each representing major manufacturers. Whether an approach based on competing consortia is superior to one focused on individual producer responsibility remains to be seen.

TABLE 1

Japanese waste-management laws

Law	Scope and subject of recovery	Year promulgated	Year enforced
Basic-framework laws			
Fundamental Law for Establishing a Sound Material-Cycle Society	Sets the legal framework, organizes priorities, and defines the responsibilities of the government, municipalities, businesses, and consumers. Under this framework, many products are subject to recovery and recycling.	2000	2001
Waste-Management Law	Requires "3Rs" measured in 10 industries and 69 product items. Covers ~50% of the waste generated in Japan.	2000	2001
Law for Promotion of Effective Utilization of Resources	Sets administrative procedures for waste-management businesses and standard procedures for managing different types of waste.	2000	2001
Industry-specific laws			
Containers and Packaging Recycling Law	Cans, bottles, trays, cartons, and cardboard boxes.	1995	1997
Home Appliance Recycling Law	Air conditioners, refrigerators (including freezers), televisions, and washing machines.	1998	2001
Food Recycling Law	Food waste generated by food manufacturers, wholesalers, retailers, and the food-service industry.	2000	2001
Construction Material Recycling Law	Construction waste that accounts for ~20% of industrial waste and 60% of illegally dumped waste.	2001	2002
End-of-Life Vehicle (ELV) Recycling Law	Automobile shredder residue from 5 million ELVs generated every year within Japan.	2003	2004

end-of-life products. Any assessment of Japan's EPR policies will need to pay close attention to collection efficiencies for manufactured goods. The number of home computers collected via the EPR-based recycling routes is estimated to be <50% of all the end-of-life computers generated in the home sector in fiscal year 2005 (FY '05), although accurate estimates are hard to come by (*5*, *6*). The remainder have flowed into Japan's thriving secondhand computer market, been handed over to third-party recyclers, or been disposed of as e-waste both within Japan and abroad. Because these computers were likely purchased before October 2003, consumer involvement in recycling is limited to voluntary payment of recycling fees at the end of life. Hence, it is not surprising that only a small fraction of such computers are taken back by computer firms. For all purchases made after that date, the cost of recycling is incorporated into the purchase price, and consumers do not pay a recycling fee at the end of life. Consequently, the proportion of computers incorporated into the recycling loop is likely to increase, because consumers will no longer absorb the costs of proper disposal in a voluntary manner. Import of end-of-life computers, including those from Japan, has to date been a significant cause of environmental health impacts in developing countries, particularly China and India (*7*). Computer manufacturers all over the world, including those in Japan, are being pressured by nongovernmental organizations and consumer groups to adopt take-back regulations (*8*). This makes it more likely that Japanese laws will, over time, result in increased collection efficiency.

Under HARL, the payment of post-use recycling fees and other collection inefficiencies may have resulted in so-called leakage. Only 50% of end-of-life appliances are estimated to be incorporated into the recycling loop, and ~10 million units remain unaccounted for annually. This is partly because some retailers at designated collection points may charge consumers a reduced recycling fee and sell the used goods to brokers for export and processing abroad (*9*). Another concern related to product leakage is illegal (curbside) disposal of goods, such as home appliances, for which consumers pay a recycling fee at the end of life under EPR laws. Approximately 2% of end-of-life home appliances (~172,000 units) were illegally disposed of in 2004; this was ~25% higher than in 2001, when HARL came into effect (*10*). The law has no mechanisms for reducing curbside disposal of appliances, and the onus is on municipalities to strengthen monitoring and prevention. For all the leakage-related reasons cited above, the home appliance law has been under review since 2006.

The ELV Recycling Law is designed so that con-

sumers' reluctance to pay the recycling fee does not lead to illegal dumping. Consumers pay a fee at the time of purchase of a new car or, for cars sold before the enforcement of the law, at the time of mandated regular inspection. The fee is managed by a third party, the Japan Automobile Recycling Promotion Center (JARC). An electronic manifest system that allows tracking of how an ELV is processed was introduced to ensure that ELVs are properly recycled. Some people have concerns that enforcement of the law may lead to an increase in export of ELVs, which is still allowed under the law. Japan is a major exporter of used vehicles—annual exports on the order of a million cars (*11*) primarily to countries that use right-hand drive vehicles. Large-scale export of roadworthy vehicles is partly facilitated by the rigorous Japanese automobile inspection systems. Inspections, which cost $1000–2000, are required every 2 years for cars ≥3 years old. However, there is little indication that ELV regulations have caused a rise in exports of cars in working condition.

ELV laws may have had a significant impact on the export of vehicles that are to be sold as scrap. The one-time cost of ELV disposal ($83–128) is only intended for domestic recycling processes and is returned to a consumer by JARC if the ELV is not recycled domestically. Before the ELV Recycling Law, the numbers of ELVs generated and exported annually were estimated to be 5 million and 1 million, respectively (*12*). Although hard data on ELV export is difficult to come by, high current global demand for scrap metals and the reimbursement of disposal costs to consumers may have increased the incentive to export ELVs that are no longer roadworthy. In FY '05, only 3.05 million ELVs were collected in accordance with the law (*13*); this is substantially lower than the forecasted 4 million (*14*). The difference appears to be due to a loophole in the ELV Recycling Law that facilitates exports. An owner can cancel a car registration without paying the recycling fee and hand the car over to illegal recyclers. Because government agencies do not keep track of deregistered ELVs, owners can walk away from their automobiles without incurring recycling fees. This problem of the "missing million" automobiles is now widely recognized, and how regulators respond to it remains to be seen (*15*).

Although processes for collection of manufactured goods have enjoyed mixed success, recycling of collected goods has performed well. A key reason for the initial successes of recycling is industrial investment both in research and development (R&D) and toward the establishment of dedicated infrastructure to improve recovery of products (see the box on p 4503). For example, appliance manufacturers began operation of large-scale recycling facilities all over Japan before the enforcement of HARL. Computer manufacturers have established recycling facilities where end-of-life computers are disassembled and separated into usable parts and materials. Vehicle manufacturers have invested in R&D of automobile shredding residue (ASR) recycling technologies, dismantling processes, and applications of recycled materials. Technological innovation

FIGURE 1

The flow of end-of-life products and roles of stakeholders under the Home Appliance Recycling Law (HARL)

Whereas new products are distributed from producers to consumers through retailers, end-of-life products flow in the opposite direction. Under HARL, all the stakeholders have commensurate responsibilities to make the system work. Although producers have to invest in a new recycling facility to fulfill the responsibility of recycling end-of-life products, the expenses of recycling and transportation are borne by consumers. Retailers also have extended responsibility for collection and transportation of end-of-life products.

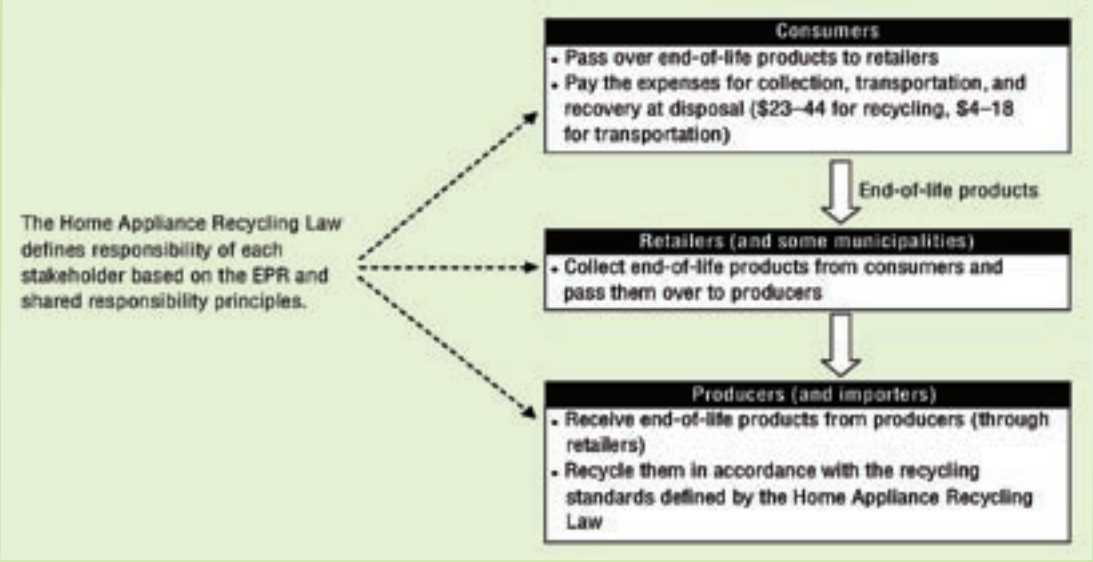

TABLE 2

Recovery rates of regulated products

Applicable law (year enforced)	Applicable products	Collected end-of-life products (units or metric tons per year)	Recovery rates*		Refs.
			Percentage actual (FY)	Standards and targets (%)	
Home Appliance Recycling Law (HARL) (2001)	Air conditioners	1,989,000	84 ('05)	60	23, 24
	Televisions	3,857,000	77 ('05)	55	
	Refrigerators and freezers	2,820,000	66 ('05)	50	
	Washing machines	2,952,000	75 ('05)	50	
Food Recycling Law (2001–)	Food waste	11.360 Mt	45 ('04)	20 (by FY '06)	25, 26
Law for the Promotion of Effective Utilization of Resources (2001–)	Desktop PCs	364,479	76 ('05)	50	6, 27
	Laptop PCs	192,059	54 ('05)	20	
	CRT monitors	349,823	78 ('05)	55	
	LCD monitors	97,289	68 ('05)	55	
	Ni–Cd rechargeable batteries	975 t	74 ('04)	60	28, 29
	Ni–MH rechargeable batteries	110 t	77 ('04)	55	
	Li-ion rechargeable batteries	226 t	55 ('04)	30	
	Small lead batteries	3939 t	50 ('04)	50	
Construction Material Recycling Law (2002)	Concrete	N/A	98 ('02)	95 (FY '10)	30, 31
	Wood	N/A	89 ('02)	95 (FY '10)	
	Asphalt concrete	N/A	99 ('02)	95 (FY '10)	
ELV Recycling Law (2005)	ELVs	3,050,000 (FY '05)	ASR recovery standards 57–68 (FY '05, for three major manufacturers)	ASR recovery standards 30 (FY '05–09) 50 (FY '10–14) 70 (FY '15–)	4, 32

ASR, automobile shredding residue; CRT, cathode ray tube; ELV, end-of-life vehicle; FY, fiscal year (from April to March of the following year); LCD, liquid crystal display; MH, metal hydride; N/A, not applicable

* Definitions of recovery rates:

Home appliances: (weight of parts reused + weight of materials recycled[a])/weight of products collected

Food waste: (weight of waste recycled[b] + weight of waste reduced[c] + weight of waste saved)/weight of food waste generated

Computers: (weight of parts reused + weight of materials recycled[d])/weight of end-of-life computers collected[e]

Batteries: weight of materials recycled/weight of batteries collected

Construction waste: weight of materials recycled/weight of waste generated

ELVs: weight of materials recycled/weight of ASR generated from collected ELVs[f]

[a] Not including materials used for energy recovery.

[b] Means of recycling include animal food production, fertilizer production, methylation, and oil and fat production.

[c] Means of reduction of food waste include drying, dewatering, fermentation, and carbonization.

[d] Materials that are chemically recycled and used for energy recovery do not count.

[e] Collected computers are from home and business sectors.

[f] The actual recycling rate of ELVs only includes data from January to March 2005 as FY '04, because the enforcement of the ELV Recycling Law began in January 2005.

throughout the product life cycle is clearly increasing recycling rates. These advances could give Japan a competitive advantage if more countries and jurisdictions demand recycling technologies.

It is useful to compare Japan's successes and failures with those of other jurisdictions that have adopted EPR legislation. In 2002, the EU adopted the Waste Electrical and Electronic Equipment Directive (WEEE Directive), which is more comprehensive than HARL. WEEE Directive targets 81 products in 10 sectors and covers both businesses and consumers. Unlike HARL, WEEE Directive does not have mandatory take-back consumer requirements and consumers do not pay a fee for post-use disposal. Although recovery rates for collected products are similar for WEEE Directive and HARL (*16*), collection rates for the EU law are estimated to be significantly lower (*17*) than the 50% collection rates for HARL. The EU is also implementing new regulations that create incentives for manufacturers to engage in increased design for disassembly, reuse, and recycling. EU manufacturers that follow specific Design for the Environment (DfE) guidelines receive a product certification label. In Japan, explicit DfE

guidelines do not exist, and manufacturers incorporate DfE as a part of their plan to meet specified recovery targets.

Although disposal costs vary across EU nations, the estimated costs of collection and recycling are higher in Japan than those in the EU, in part because of higher capital expenditures and costs associated with technological development (*16*). However, some evidence suggests that EPR laws are bringing down costs of disposal within Japan. Consider, for example, the shifting of responsibility for waste management away from municipalities toward the private sector under HARL. The average cost of processing home appliances by the Tokyo Metropolitan Government before the implementation of the law was estimated at ¥6200 ($56) for a television to ¥15,800 ($144) for an air conditioner. After the enforcement of the law, recycling costs for appliances are roughly equal to the recycling fees paid by consumers. The average cost of recycling was estimated to be $25–27 for a television, and $52 for an air conditioner (*18*).

HYPER CYCLE SYSTEMS CORP.

End-of-life home appliances are disassembled, separated, and recycled as raw materials. Hyper Cycle Systems, Chiba Prefecture, has the capacity to process >500 t of end-of-life home appliances and computer equipment per day (20-h operation).

Adapting and innovating

An important feature of Japanese EPR laws is that they are based on the shared-responsibility principle (*19*), in which the responsibility for taking back and recovering end-of-life products for different stakeholders is made explicit. When coupled with a mandatory take-back policy, explicit articulation of responsibilities helps reveal inefficiencies in collection and recycling that may otherwise remain hidden. Japanese laws also recognize that different products face varying after-market conditions and that legislation needs to be tailored appropriately and adapted over time to changing markets. This is revealed in several laws that are under review after the first few years of the EPR experience.

The enforcement of the comprehensive recycling laws in Japan is advancing innovation in environmental technologies. Areas of technological innovation include development of "building-block" processes, such as new techniques for the separation of materials, and the operation of society-level pilot systems with complex resource-recovery mechanisms. However, illegal disposals and increases in the export of end-of-life products have led to collection efficiencies of ~50% for manufactured goods. Also, Japanese EPR laws have focused exclusively on closing the loop on materials and not on other considerations, such as reducing life-cycle energy use and emissions. How subsequent reviews of Japan's EPR legislation address these challenges remains to be seen.

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