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Closing the Loop: Product Take-Back Regulations and Their Strategic Implications

Michael W. Toffel

In Asia, Europe, and North America, regulators are seeking to reduce waste disposal and develop recycling markets by requiring manufacturers to manage the end-of-life disposition of products they produce. Such policies attempt to "close the loop" for products ranging from electronics to vehicles by creating incentives for manufacturers to increase the usage intensity of materials embodied in their products to reduce the demand for virgin raw materials and energy. This article describes take-back regulations and highlights some of their key features. In addition, several product take-back strategies are presented along with a few key questions managers should consider in selecting an appropriate strategy for their company.

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Introduction

Product take-back requirements represent a novel but burgeoning regulatory approach to reducing the volume and toxicity of waste. Take-back laws and regulations require companies to manage the disposition of products they manufacturer at their end-of-life (EOL). Such requirements are intended to have manufacturers realize EOL

costs, thus providing an incentive to manage the full lifecycle cost of their products. Take-back laws are an application of the Polluter Pays Principle, a regulatory approach endorsed by the Organisation for Economic Cooperation and Development (OECD) in 1972.¹ Adherents to this principle call for policies to have "polluters and users of natural resources bear the full environmental and social costs of their activities"² to embed these costs into market prices, with the goal of internalizing environmental externalities.

Take-back laws, primarily found in Europe and East Asia, have targeted packaging, batteries, automobiles, as well as electrical and

¹ OECD, "Guiding Principles Concerning International Economic Aspects of Environmental Policies," (Paris: Organisation for Economic Co-operation and Development, 1972) <<http://sedac.ciesin.org/pidb/texts/oecd/OECD-4.01.html>>

² D. Hunter, J. Salzman, and D. Zaelke, *International Environmental Law and Policy* (New York: Foundation Press, 2002).

electronic products. The German *Ordinance on the Avoidance of Packaging Waste* (1991) was the first take-back law. This made manufacturers responsible for the cost of collecting, sorting, and recycling packaging associated with their products and required companies to label their packaging with its material composition and its return/reuse system.³ Several years later, the European Union (EU) passed a *Directive on Packaging and Packaging Waste* requiring its Member States to establish waste packaging recycling targets and allocate recycling costs to packaging raw material suppliers, packaging manufacturers, and producers, distributors, and retailers of packaged goods—but not customers or taxpayers.⁴

Batteries are subject to take-back laws in Germany, The Netherlands, and Norway.⁵ Several US states have also implemented take-back regulations on batteries. Florida, Minnesota, and New Jersey require manufacturers to take-back and manage the disposal of the rechargeable batteries they produce, while rechargeable battery manufacturers in Rhode Island and Vermont must ensure that a collection, transportation, and processing system is established.⁶

Automobiles are the target of take-back regulations in Japan and Europe. In Japan, regulators have focused their attention on the 20 percent of automobiles not already recycled

for spare parts and scrap value. Effective in 2004, automakers and importers will be required to pay for the recycling of vehicle shredder dust, air bags, and ozone-depleting gases from air conditioners.⁷ Following initiatives by several France, Germany, Italy, and Netherlands,⁸ the EU *Directive on End-of-Life Vehicles* (2000)⁹ requires automakers to reuse or recycle 85 percent of an EOL automobile's weight by 2006, a target that increases to 95 percent by 2015. The Directive requires manufacturers to set aside billions of euros to process cars built before 2002, while cars built after 2002 will include a tax to fund recycling at their EOL.¹⁰

Already the most popular target of take-back regulations, policy makers from many additional countries are beginning to implement take-back laws and regulations for waste electrical and electronic equipment (WEEE). In East Asia, Japan, Taiwan, and Korea have promulgated product take-back regulations for WEEE. Japan requires manufacturers to recycle televisions, refrigerators, washing machines, air conditioners, rechargeable batteries and some computers.¹¹ Belgium, Denmark,

⁷ Car owners slapped with cost of recycling scrap, *Mainichi Daily News* (July 5, 2002) 8. Diet enacts auto recycling legislation, *The Japan Times* (July 6, 2002).

⁸ F. den Hond, "In Search of a Useful Theory of Environmental Strategy: A Case Study on the Recycling of End-of-Life Vehicles from the Capabilities Perspective," (Vrije Universiteit Amsterdam, 1996) <http://home.scw.vu.nl/~den_hond/>

⁹ Directive 2000/53/EC of the European Parliament and of the Council of September 18, 2000 on end-of life vehicles. See 269 Official Journal L 34 (Oct 21, 2000).

¹⁰ International Association of Electronics Recycling. Electronics Recycling Newsletter. See <http://www.iaer.org/communications/NL0401.html>, sourced Feb 18, 2002.

¹¹ N. Tojo, "Analysis of EPR Policies and Legislation through Comparative Study of Selected EPR Programmes for EEE," *IIIEE Communications*, 10 (2000); T. Fujii, Japan Business Council in Europe, "The Development of Japan's Take-Back Regulations and Business Impact," Presented at the European Electronics Take-back Legislation: Impacts on Business Strategy and Global Trade Workshop, INSEAD, Fontainebleau, France

³ Alliance of Foam Packaging Recyclers. The Ins and Outs of German Packaging Regulations. See <http://www.epspackaging.org/agermany.html>, sourced November 21, 2002.

⁴ European Parliament and Council Directive 94/62/EC of 20 December 1994 on Packaging and Packaging Waste. *Official Journal of the European Communities*, No L 365/10 (December 31, 1994).

⁵ US Environmental Protection Agency. Product Stewardship. See <http://www.epa.gov/epr/about/index.html>, sourced Feb 18, 2002.

⁶ B. Fishbein, "EPR: What Does It Mean? Where Is It Headed?," *P2: Pollution Prevention Review*, 8 (4.) (1998) 43-55. US Environmental Protection Agency. Product Stewardship. See <http://www.epa.gov/epr/about/index.html>, sourced Feb 18, 2002.

Italy, Netherlands, Norway, Sweden, Switzerland, and Portugal had already adopted some take-back policies for WEEE before the EU passed its *Directive on Waste Electrical and Electronic Equipment* (2003) requiring all Member States to do so.¹² The WEEE Directive requires all Member States to promulgate legislation requiring manufacturers of a wide variety of electrical and electronic products to bear all costs incurred in the recycling and waste management of their EOL products.

While the United States has largely eschewed legislating product take-back, the past few years have seen bills introduced in many state legislatures calling for electronics recycling and advance deposit fees. In the 2003 session, bills addressing electronic waste were introduced in California, Massachusetts, Minnesota, Rhode Island, Texas, Vermont, and

Washington.¹³ California recently passed legislation imposing a \$6 to \$10 “electronic waste recycling fee” on the sale of new monitors and televisions (both cathode ray tube and flat panel devices) and requires manufacturers to inform consumers how to recycle or dispose of these products.¹⁴ Retailers will collect and transfer the fees to a government agency that will be allocate funding to organizations involved in recovering and recycling these devices. Earlier drafts of the bill were significantly more comprehensive, including requiring manufacturers of a broader set of electronics (including computers) to ensure that by 2005, at least 50 percent of the volume sold in California the previous year would be diverted from waste disposal and recovered for reuse or recycling, with this target rising in subsequent years.¹⁵ The version that passed requires the state to establish vague recycling goals, but specifically *prevents* regulators from establishing “any recycling goal or target on a manufacturer of those devices.” Additional language struck from earlier versions would have required the state government to certify each manufacturer’s plan for the collection, handling, transportation, processing, recovery, reuse, and recycling of its EOL products. On the national level, a bill was introduced in March 2003 in the US House of Representatives (HR 1165) seeking to impose a fee on the sale of computers and monitors to fund their recycling, reuse, and resale. Six months

(October 17-18, 2002). US Environmental Protection Agency. Product Stewardship. See <http://www.epa.gov/epr/about/index.html>, sourced Feb 18, 2002.

¹² CECED, "Initiatives undertaken by EU Member States and Norway and Switzerland to deal with take-back and proper treatment of waste electrical and electronic equipment (WEEE): Status report," (Brussels: European Committee of Manufacturers of Domestic Equipment, 2002) <<http://www.ceced.org/statements/index.html?gid=144&r=1>> European Commission, "Amended Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment. COM(2001) 315 final." 2001. European Parliament delegation to the Conciliation Committee, "Report on the joint text approved by the Conciliation Committee for a European Parliament and Council Directive on waste electrical and electronic equipment (WEEE) (PE-CONS 3663/2002 - C5-0486/2002 - 2000/0158(COD))." 2002. C. K. Lin, L. Yan, and A. N. Davis, "Globalization, Extended Producer Responsibility and the Problem of Discarded Computers in China: An Exploratory Proposal for Environmental Protection," *Georgetown International Environmental Law Review*, 14 (2002) 525-576. Raymond Communications, "Electronics Recycling: What to Expect from Global Mandates," (College Park, MD: 2000) <http://www.raymond.com/promo_raymond-international/weesum.pdf>

¹³ These bills are California Senate Bill 20, Massachusetts H 1533, Minnesota SF0838 and HF0882, Rhode Island HB 5783, Texas SB 1239 and HB 2967, Vermont H 343, and Washington HB 1942. In addition bills were introduced but failed in Florida (SB 674) and Maine (LD 743). Two Connecticut bills (HB 6259 and 6269) propose a government-run program funded by a fee on cathode ray tube devices that would offer grants to third-party recycling companies. The Computer Takeback Campaign tracks legislation related to electronic wastes. See <http://www.svtc.org/cleancc>

¹⁴ California State Senate Bill Information, Senate Bill No. 20, chaptered Sept. 25, 2003

¹⁵ California State Senate Bill Information, Senate Bill No. 20 amended in Senate, June 2, 2003.

later, this bill remains pending with limited support.

The Objectives of Take-Back Policies

Take-back legislation addresses three objectives: reducing the volume and toxicity of waste disposal, increasing recycling rates, and preventing pollution at its source. To achieve the first objective, take-back legislation often targets products containing hazardous materials that are either destined for landfills, where they can leach into the environment,¹⁶ or incinerators, where they can be mobilized into the atmosphere. To reduce the volume and toxicity of waste disposal, take-back policies often define acceptable forms of disposition. For example, the EU's *Directive on Packaging and Packaging Waste* and *Directive on Waste Electrical and Electronic Equipment* incorporate in their definition of "recovery" several options including recycling, waste-to-energy incineration and composting.

The second objective of take-back policies is stimulating the market for recycled materials by increasing their supply and reducing their prices relative to virgin materials. Switching from the use of virgin to recycled materials not only makes use of materials otherwise destined for landfills or incinerators, but also reduces energy use when recycling is less energy intense than extracting virgin materials, as is the case with many materials including aluminum, steel, glass, cement, and silicon.¹⁷ Some take-back regulations stipulate minimum collection, re-use, and recycling rates. For example, the EU packaging directive requires Member States to establish minimum recovery and recycling rates for packaging

waste.¹⁸ The EU WEEE Directive requires Member States to provide evidence by 2006 that they are collecting 4 kg of WEEE per person per year, and that they are recycling 50 percent of small EOL household appliances and 75 percent of large EOL household appliances.

The unique feature of take-back policies is that they can accomplish these two objectives while achieving a third: creating incentives for product designers and engineers to reduce the environmental burden of EOL products. These are key product stages for policies to target because many recycling and disposal costs are functions of the materials used in products and their assembly techniques, decisions made during product design and engineering. The Explanatory Memorandum accompanying the EU's *Proposal for a Directive on Waste Electrical and Electronic Equipment* states: "Producers should take the responsibility for certain phases of the waste management of their products. This financial or physical responsibility creates an economic incentive for producers to adapt the design of their products to the prerequisites of sound waste management."¹⁹ The memo makes explicit the particular leverage of assigning responsibilities to producers. "Producers of electrical and electronic equipment design the product, determine its specifications and select its materials. Only producers can develop approaches to the design and manufacture of their products to ensure the longest possible product

¹⁸ European Parliament and Council Directive 94/62/EC of 20 December 1994 on Packaging and Packaging Waste. *Official Journal of the European Communities*, No L 365/10 (December 31, 1994).

¹⁹ European Commission, "Explanatory Memorandum to the Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment and Proposal for a Directive of the European Parliament and of the Council on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment. COM(2000) 347 final," (Brussels: 2000) <http://europa.eu.int/eur-lex/en/com/pdf/2000/en_500PC0347_02.pdf>

¹⁶ S. E. Musson, Y.-C. Jang, T. G. Townsend, and I.-H. Chung, "Characterization of Lead Leachability from Cathode Ray Tubes Using the Toxicity Characteristic Leaching Procedure," *Environmental Science & Technology*, 34 (20.) (2000) 4376-4381.

¹⁷ P. Hawken, A. B. Lovins, and L. H. Lovins, *Natural Capitalism: Creating the Next Industrial Revolution*, 1st ed. (Boston: Little Brown and Co., 1999).

life and, in the event that it is scrapped, the best methods of recovery and disposal.”²⁰

Product designers and engineers can, for example, increase the durability of products, components, and materials and facilitate their repair, disassembly, refurbishment, and recyclability. According to the Electronic Industries Alliance, a consortium of US trade associations, product designers of electronics are attempting to reduce the EOL environment burden of their products through design changes that include: improving the ability for products to be refurbished or repaired (e.g., using modular components that can be reused in new models or as spare parts); reducing disassembly and recycling costs by using snap-fit assembly, fewer materials and components, fewer toxic substances, and more clearly labeling material content; promoting recyclability by avoiding the use of coatings and paints; using recycled material; and incorporating residual values into material selection rather than simply the initial prices.²¹ Germany’s packaging take-back regulations have forced the redesign of packaging.²²

Types of Responsibility

Take-back laws and regulations impose upon manufacturers physical, economic, informative, or various combinations of these respon-

sibilities.²³ Policies that assign physical responsibility require manufacturers to engage in the physical management of their EOL products. More commonly, take-back policies impose economic responsibilities by requiring manufacturers to pay at least a portion of the EOL costs incurred in the collection, separation, recycling, and disposal of their products. Policies that impose informative responsibilities may require manufacturers to maintain or disclose information about their customers or products to reduce the cost of EOL product recycling. Requiring manufacturers to label the contents of all plastic resins to reduce the cost of identifying them during recycling operations is one example.

Policies that impose economic or physical responsibilities must specify which stages of the product recovery process are included. Collection from households has been the most controversial. State and municipal governments typically manage the infrastructure that collects from households municipal solid waste and often recyclable commodities such as glass, paper, and aluminum. While these governments are often eager to reduce their collection costs, manufacturers argue that household collection—even of products targeted by take-back policies—is a public sector responsibility. While the WEEE Directive requires EU Member States to establish collection systems for households, manufacturers are held financially responsible for the subsequent costs of transporting EOL products from these collection points for treatment, re-use and recycling, as well as for the collection of EOL products from commercial and industrial sites.

Preventing Future Historical Waste

Not all manufacturers of today’s products will still be around when their products are dis-

²⁰ European Commission, "Explanatory Memorandum to the Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment and Proposal for a Directive of the European Parliament and of the Council on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment. COM(2000) 347 final," (Brussels: 2000) <http://europa.eu.int/lex/en/com/pdf/2000/en_500PC0347_02.pdf>

²¹ Electronic Industries Alliance, "Addressing End-Of-Life Electronics Through Design: A Compendium of Design-For-Environment Efforts of EIA Members," (Arlington, Virginia: 1998) <<http://www.eia.org/resources/1998-01-01.11.pdf>>

²² F. Cairncross, "How Europe’s Companies Reposition to Recycle," *Harvard Business Review*, 70 (2.) (1992) 34-45.

²³ T. Lindhqvist, "Extended Producer Responsibility," Presented at the Conference on Extended Producer Responsibility as a Strategy to Promote Cleaner Production, Trolleholm Castle, Sweden (May 4-5, 1992): 1-5.

posed of, particularly those who produce products with long life spans and those in industries with high rates of company exit. How can regulators require a company that no longer exists to pay for its EOL products? Some take-back policies are anticipating this issue by requiring producers to provide a financial guarantee, which could assume the form of insurance, at the time of sale that ensures they will pay the waste management costs upon the product's EOL. Orgalime, a federation representing over 100,000 companies in the mechanical, electrical, electronic and metal working industries across 21 European countries, has referred to this requirement as being "of utmost importance...to prevent free-riding."²⁴

Individual or Collective Responsibility?

Take-back legislation can impose individual or collective responsibility on manufacturers to finance EOL product recovery. While collective responsibility imposes this responsibility on all companies within an industry for the industry's products, individual responsibility holds manufacturers responsible only for their own EOL products. While collective operations can eliminate the cost of counting or sorting EOL products by manufacturer, it creates the need for regulations to define the boundaries of each industry and to define some method to allocate costs to manufacturers (e.g., current market share). In addition, this distinction is of critical importance to achieving take-back policies' objective of creating incentives for producers to invest in product design and engineering changes that prevent waste and facilitate recycling. Many companies and trade associations maintain that only individual responsibility provides this incentive because collective responsibility dilutes a company's returns from such investments. As such, under collective respon-

²⁴ Orgalime, "Orgalime Guidance on Producer Responsibility in the Proposed WEEE Directive: Notes for the conciliation process" (Brussels: 2002) <<http://www.orgalime.org/pdf/Weeec0702.pdf>>

sibility the incentives to make such investments are substantially eroded and companies have the incentive to free ride. Despite these benefits of individual financial responsibility, take-back legislation in Austria, Belgium, The Netherlands, Norway and Sweden imposed collective financial responsibility.²⁵ After a host of companies, trade associations, and environmental citizen groups across Europe lobbied the EU, the WEEE Directive provides for individual financial responsibility.²⁶

Benefits and Costs of Take-Back Policies

Environmental concerns associated with land-filling waste electronics include the leaching and evaporation of hazardous substances including lead, mercury, cadmium, PCBs, brominated flame retardants.²⁷ Incinerating waste electronics mobilizes heavy metals, creates

²⁵ CECED, "Initiatives undertaken by EU Member States and Norway and Switzerland to deal with take-back and proper treatment of waste electrical and electronic equipment (WEEE): Status report," (Brussels: European Committee of Manufacturers of Domestic Equipment, 2002) <<http://www.ceced.org/statements/index.html?gid=144&r=1>>

²⁶ ISR-CER. Waste Electrical and Electronic Equipment (WEEE). See <http://www.isrcer.org/informcer.htm>, sourced November 20, 2002; CECED. Waste Electrical and Electronic Equipment: The European Domestic Appliance Industry's Questions & Answers Concerning WEEE. See http://www.ceced.org/energy/CECED_FAQ_EOL.doc, sourced Nov. 20, 2002; E. Lymberidi, "Towards Waste-Free Electrical And Electronic Equipment," ((Brussels: European Environmental Bureau, 2001) <http://www.eeb.org/publication/Towards_waste-free.pdf>

²⁷ European Commission, "Explanatory Memorandum to the Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment and Proposal for a Directive of the European Parliament and of the Council on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment. COM(2000) 347 final," (Brussels: 2000) <http://europa.eu.int/lex/en/com/pdf/2000/en_500PC0347_02.pdf>

dioxins, furans, and other hazardous combustion products including incinerator ash with high levels of metals. Take-back regulation can make a profound impact on diverting to recycling wastes otherwise destined to landfills or incinerations. In its first year alone, Japan's *Household Appliance Recycling Law* collected over 8.5 million WEEE units, including 3 million televisions.²⁸ Design changes made in response to take-back requirements are likely to be disseminated globally when a single product design is distributed globally (e.g., laptop computers).

While recycling reduces the amount of toxic materials heading to landfills and incinerators, recycling has its own environmental burdens associated with transportation and reprocessing. Such trade-offs have been evaluated in three studies that have employed a life cycle assessment (LCA) approach to predict the net environmental impact of implementing the requirements of the WEEE Directive. Two studies evaluated several household electronic products and concluded that the higher recycling rates mandated by the WEEE Directive would reduce most environmental impacts associated with landfilling WEEE, the prevailing disposal practice in the UK.²⁹ A third

study focused on computer printers and reported mixed results, concluding that the WEEE Directive would improve some environmental aspects such as air acidification and resource depletion but would worsen others including ecological toxicity and global warming potential.³⁰

As for financial costs, the WEEE Directive may impose costs to producers amounting to one to two percent of turnover, according to Kieren Mayers, Manager of Sony International (Europe)'s Environmental Center Europe.³¹ Orgalime estimates the cost to the electrical and electronic industry of implementing the WEEE Directive will be €7.5 billion per year.³² The UK Department of Trade and Industry recently estimated that implementing the WEEE Directive in the UK would cost £328 to £509 per tonne of collected WEEE for collection, treatment, reuse and recovery activities.³³ Annual costs of these activities are

²⁸ C. K. Mayers, "Electronics Recycling Implementation: Legislation, Business Implications, and Strategy," Presented at the European Electronics Take-back Legislation: Impacts on Business Strategy and Global Trade Workshop, INSEAD, Fontainebleau, France (October 17-18, 2002).

²⁹ The first study was conducted in 1999 and revised in 2002. The revised version found that most environmental impact categories would improve by at least 10% for PCs, televisions, lawnmowers, and vacuum cleaners, and many would improve by over 50%. However, recycling of washing machines and refrigerators were expected to increase hazardous waste and water toxicity. PriceWaterhouseCoopers, "Environmental Life Cycle Assessment and Financial Life Cycle Analysis of the WEEE Directive and its implications for the UK," (London: Department of Trade and Industry, 2002) <<http://www.dti.gov.uk/support/dtiweeupdate.pdf>> Ecobalance UK and Dames & Moore, "Life Cycle Assessment and Life Cycle Financial Analysis of the Proposal for a Directive on Waste from Electrical and

Electronic Equipment. Final Report, (ECO UK/C134)," (London: Department of Trade and Industry, 1999) A. Landfield, "An Integrated Life Cycle Assessment and Financial Analysis of the Implications of Implementing the Proposed Waste from Electrical and Electronic Equipment (WEEE) Directive," Presented at the International Conference & Exhibition on Life Cycle Assessment: Tools for Sustainability, Arlington, Virginia (April 25-27, 2000).

³⁰ C. K. Mayers, "Implications and Effectiveness of Producer Responsibility for the Disposal of Waste Electrical and Electronic Equipment (WEEE)." Doctoral Thesis, Department of Manufacturing and Engineering Systems, Brunel University (2002).

³¹ C. K. Mayers, "Electronics Recycling Implementation: Legislation, Business Implications, and Strategy," Presented at the European Electronics Take-back Legislation: Impacts on Business Strategy and Global Trade Workshop, INSEAD, Fontainebleau, France (October 17-18, 2002).

³² V. Sundberg, Director of European Affairs, Electrolux, "WEEE- The Impact on Producers and Industry," Presented at the European Electronics Take-back Legislation: Impacts on Business Strategy and Global Trade Workshop, INSEAD, Fontainebleau, France (October 17-18, 2002).

³³ UK Department of Trade and Industry, "Discussion Paper of 28 March 2003 by the UK Government, Scottish Executive, Welsh Assembly Government, Northern Ireland Administration on the Imple-

estimated at £175 to £419 million. Providing information to consumers, treatment facilities, and program registers was estimated to cost an additional £37 million per year. ElectroLux estimates that complying with the WEEE Directive and another EU Directive banning the use of a few heavy metals and flame retardants could add over \$20 to the price of a new washing machine.³⁴

Product Recovery Strategies

Manufacturers are pursuing several strategies to deal with pressures to take-back their EOL products, including encouraging customers to use the existing recycling infrastructure, developing partnerships with recyclers, and collaborating with competitors.

Promoting the Recycling Market

Manufacturers of products that are not subject to take-back regulations can encourage consumers to utilize the existing recycling infrastructure. For example, Canon directs its US customers to the Electronic Industries Alliance's *Consumer Education Initiative* and the International Association of Electronics Recyclers' *Directory of the Electronics Recycling Industry* websites to learn about recycling and reuse programs in their locale. To encourage computer reuse and recycling, Gateway offers a \$50 rebate off the purchase of one of its new computers to consumers donating their old

mentation of Directives of the European Council and Parliament: 2002/96/EC of 27 January 2003 Waste Electrical and Electronic Equipment (WEEE) and 2002/95/EC of 27 January 2003 Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (ROHS)," Publication URN 03/811, London, available at <www.dti.gov.uk/sustainability/weee/index.htm>, accessed April 13, 2003.

³⁴ Letsrecycle.com. Manufacturers link up to tackle Waste Electrical and Electronic Equipment. See www.letsrecycle.com/wasteman/news.jsp?story=1844, sourced Jan. 8, 2003.

computers to a charity or a recycler.³⁵ Apple Computer designs its products to reduce the cost of their disassembly and recycling, but is not involved in product recovery for its mainstream US customers. Canon, Hewlett Packard, Sony, Toshiba, and other appliance manufacturers have sponsored WEEE collection events in the US at BestBuy stores, a major retailer of consumer electronics.³⁶

Partnerships with Recyclers

Some manufacturers are partnering with recyclers to recycle and possibly recover components from EOL products either by establishing long-term contracts or joint ventures. For example, Nokia authorized ReCellular, Inc. to be its North American service and remanufacture center for its cellular telephones.³⁷ Dell offers a Value Recovery Service where it packs up EOL computers from customer sites and ships most of them directly to a few recyclers with whom it has long-term relation-

³⁵ Gateway. Recycle or Donate Your Old PC. See http://www.gateway.com/home/programs/tradein_recycle.shtml, sourced Apr. 15, 2002.

³⁶ Electronic Industries Alliance Consumer Education Initiative, "NERC/EIA Consumer Electronics Recycling Event in NH" (September 20, 2002). <<http://www.eiae.org/whatsnew/news.cfm?ID=66>>. Electronic Industries Alliance Consumer Education Initiative, "Best Buy/ EIA/ FL DEP Collection Event in Orlando" (October 22, 2002). <<http://www.eiae.org/whatsnew/news.cfm?ID=67>>. Northwest Product Stewardship Council. Products / Sectors - Electronic Equipment and Product Stewardship. See

<http://www.productstewardship.net/productsElectronicsBusinessPrograms.html>, sourced November 24, 2002. Best Buy, in turn, hires recycling companies to carry out the recycling services. Business Wire, "Best Buy Announces Electronics Recycling Program" (April 19, 2001). <<http://www.crra.com/ewaste/articles/bestbuy.shtml>>.

³⁷ V. D. R. Guide, V. Jayaraman, R. Srivastava, and W. C. Benton, "Supply-Chain Management for Recoverable Manufacturing Systems," *Interfaces*, 30 (3.) (2000) 125-142.

ships.³⁸ Deere & Company and Springfield Remanufacturing Corporation formed a joint-venture company, ReGen Technologies, to remanufacture diesel engines and engine-related components for Deere's dealers and customers. Hewlett-Packard partners with Noranda, a mining company, to operate two electronics recycling facilities in the US while some recovered components are sold on the secondary market and recovered fine metals are shipped to Noranda's smelters.

Collaborations with Competitors and Suppliers

Some manufacturers are working together to gain economies of scale. For example, several manufacturers of single-use cameras are working together in Europe and have designated one company in each country or region to manage the initial stages of EOL product recovery. The collected products can then be disassembled and their components inspected before they are shipped to their original manufacturer, reserving this additional transportation cost for only those components with residual value.³⁹ Honeywell (formerly AlliedSignal)'s carpet manufacturer division and DSM Chemicals North America, a producer of raw materials for nylons, established Evergreen Nylon Recycling LLC as a joint venture to recycle used carpets. More common than partnerships exclusively among manufacturers are those that include manufacturers and recyclers. For example, manufacturers across various industries responded to the German packaging ordinance by establishing a non-profit organization that recycles their products' packaging.

Industry consortia are common in countries having implemented take-back regulations for WEEE, including Umweltforum Haushalt

(UFH) in Austria, Recupel in Belgium, and Nederlandse vereniging Verwijdering Metalektronica Producten (NVMP) in The Netherlands.⁴⁰ In Sweden, the Swedish Association of Local Authorities (RVF) and El-Kretsen AB operate the Elretur system where local authorities manage collection operations and producers collectively manage treatment.⁴¹ In Norway, three companies manage WEEE collection and recycling, two of which created a joint venture, El-retur, which has contracted with several other companies for collection and treatment.⁴² In response to the EU WEEE Directive, four companies that produce 14 percent of Europe's electronic waste— Braun, Electrolux, Sony and Hewlett-Packard — recently announced their intention to collaborate recycling efforts throughout Europe to negotiate lower prices with recyclers.⁴³ In Japan, the electronics industry developed two consortia to manage WEEE collection and recycling. Matsushita and Toshiba formed one alliance, while Sony, Sanyo, Sharp, Hitachi, and Mitsubishi formed another.⁴⁴ In the US,

⁴⁰ CECED, "Initiatives undertaken by EU Member States and Norway and Switzerland to deal with take-back and proper treatment of waste electrical and electronic equipment (WEEE): Status report," (Brussels: European Committee of Manufacturers of Domestic Equipment, 2002) <<http://www.ceced.org/statements/index.html?gid=144&r=1>>

⁴¹ RVF - The Swedish Association of Waste Management, "Swedish Waste Management 2002: Electric and electronic waste," (Malmö, Sweden: 2002) <<http://www.rvf.se/startsidan.html>>

⁴² The three companies are RENAS AS, Hvittevareretur AS, and Elektronikkretur AS. El-RETUR, "Environmental Report 2001," (Oslo: Elektronikkretur AS and Hvittevareretur AS, 2002)

⁴³ V. Houlder, "Councils clash with electrical goods industry over waste laws," *Financial Times (London)* (Dec. 28, 2002): 4. Hewlett-Packard, "Braun, Electrolux, HP and Sony launch the first pan-European recycling platform" (Dec. 18, 2002). <http://www2.hp.se/press/pressrelease.asp?news_id=1432>.

⁴⁴ C. K. Mayers, "Electronics Recycling Implementation: Legislation, Business Implications, and Strategy," Presented at the European Electronics Take-back Legislation: Impacts on Business Strategy and Global Trade Work-

³⁸ Personal communication with B. Watson, Manager-Asset Recovery Services, Dell Financial Services (Apr. 16, 2002).

³⁹ G. Ferrer and D. C. Whybark, "From Garbage to Goods: Successful Remanufacturing Systems and Skills," *Business Horizons*, 43 (6.) (2000) 55-64.

rechargeable battery manufacturers established the Rechargeable Battery Recycling Corporation to manage the collection and recycling of these batteries. In Australia, cell phone carriers, service providers, and twelve phone manufacturers developed and fund the Mobile Phone Industry Recycling Program (MPIRP) in 1999, where a contracted waste management company has collected and recycled over 250,000 handsets and 500,000 batteries from over 1600 drop-off points.⁴⁵

Vertically Integrate into Product Recovery

When manufacturers vertically integrate into product recovery, they invest in the infrastructure and skills required to recover and disassemble EOL products, refurbish components, and recycle materials. With vertical integration, manufacturers can acquire tacit knowledge about their EOL products and leverage this in designing and engineering future product to optimize component and material durability, disassembly, and recyclability. For example, IBM's wholly-owned Asset Recovery Centers accept any manufacturer's central processing unit (CPU), monitor, and peripherals (keyboards, mice, printers, scanners) and then refurbish, donate, or recycle them.⁴⁶ These recovery centers "share their experiences and recommendations with IBM product development teams to ensure that issues affecting the end-of-life management of products can be addressed early in the design of new products."⁴⁷ IBM designs their prod-

ucts for upgradeability, reusability, recyclability, and safe disposal.⁴⁸

Selecting Take-Back Strategies

Managers should consider several factors when developing their company's product take-back strategy. The types of responsibility and operational flexibility provided by legislation may narrow the available set of options in particular jurisdictions. In addition, national differences in the geographic concentration of customers, transportation infrastructure, and recycling infrastructure may play an important role in selecting a product recovery strategy. These two factors suggest that a company's strategy may differ by product and country. Managers should also consider the following questions when developing a take-back strategy.

Can your firm save costs by using components and materials harvested from your EOL products?

When refurbished or recycled components are expected to reduce manufacturing or repair costs, the decision whether to vertically integrate into product recovery should be viewed as *both* forward integration into a post-distribution activity and backward integration into a new source of supply. Key factors include whether the full cost of refurbishing any components is anticipated to be cheaper than procuring or fabricating virgin components, and similarly whether any recovered materials are likely to be cheaper than virgin materials. For example, Xerox Corporation has saved millions of dollars by taking back their EOL photocopiers and refurbishing their components for reuse as substitutes for virgin components.

shop, INSEAD, Fontainebleau, France (October 17-18, 2002).

⁴⁵ Australian Mobile Telecommunications Association. <http://www.amta.org.au> (Accessed July 6, 2003).

⁴⁶ IBM. IBM PC Recycling Service. See http://www.ibm.com/ibm/environment/products/pc_rservice.phtml, sourced Jan 25, 2002.

⁴⁷ IBM, "2001 Environment and Well-Being Report -- Product Stewardship," (Somers, NY: 2001) <<http://www.ibm.com/ibm/environment/annual2001/product.phtml>>

⁴⁸ IBM, "2001 Environment and Well-Being Report -- Product Stewardship," (Somers, NY: 2001) <<http://www.ibm.com/ibm/environment/annual2001/product.phtml>>

Does your firm have concerns about sharing proprietary information?

Some manufacturers view as proprietary the material content of their components. If a manufacturer employs an independent recycler or join a consortium co-owned by its competitors, minimizing product recovery costs may require sharing this information. For example, if a manufacturer views the material composition of its plastic components as proprietary, an independent recycler may only be able to identify its composition through the use of expensive specialized equipment, whereas the manufacturer could quickly identify the materials based on its proprietary specifications.

Does your firm value your EOL products more than anyone else?

A manufacturer's product recovery strategy may also be influenced by the components and materials employed in its products. If the manufacturer uses specialized materials or wants to deter other firms from refurbishing their EOL products, it may value its EOL products more than other companies. In this case, contracting with an independent recycler can present problems, especially when the valuation discrepancy is large.⁴⁹ While the independent recycler would seek to price the recycled material as close to the manufacturer's outside option of virgin material, the manufacturer would seek to negotiate the price down to the amount the second highest bidder is willing to pay. To mitigate this hold-up concern that arises when dealing with independent recyclers, manufacturers that especially value their EOL products may create joint ventures or vertically integrate into product recovery. For example, Kodak has developed a long term relationship with one organization to disassemble their one-time-use cameras to enable Kodak to test, inspect,

⁴⁹ B. Klein and K. B. Leffler, "The Role of Market Forces in Assuring Contractual Performance," *Journal of Political Economy*, 89 (4.) (1981) 615-641.

and reuse the chassis, basic camera mechanism and electronic flash system to produce new cameras.⁵⁰ Hewlett-Packard, eager to prevent other firms from refilling and selling its spent toner cartridges, offers customers a convenient way to return used cartridges directly to Hewlett-Packard, which recycles their plastics and metals.

Does your firm possess capabilities that can be leveraged in take-back operations?

Manufacturers should consider vertically integrating into product recovery when they can leverage competitive advantages in logistics, manufacturing, or assembly into product recovery's reverse logistics, remanufacturing, or disassembly. Similarly, manufacturers with service and repair capabilities may gain competitive advantages in quickly and accurately identifying repairable products and reusable components.

Conclusions

Manufacturers selling products into markets with take-back regulations are already facing new requirements to manage or at least pay for the recycling and disposal of their EOL products. The EU WEEE Directive is dramatically increasing the number of countries with take-back regulations for electronics products, and support for product take-back regulations is growing in the US at the state level. With take-back regulations spreading both geographically and across additional industries, the number of companies facing the challenge of crafting cost-effective EOL product management

⁵⁰ Kodak, "KODAK Recycles Its 50-Millionth One-Time-Use Camera" (July 19, 1995). <<http://www.kodak.com/US/en/corp/pressRel/eases/pr19950720-1.shtml>>. Kodak. 2001 Health, Safety & Environmental Report: The Kodak Single-Use Camera Story. See http://www.kodak.com/US/en/corp/environment/01CorpEnviroRpt/practices_camera.jhtml, sourced July 7, 2003.

strategies will continue to grow. Companies perceiving EOL product take-back as a strategic issue can begin contemplating how to gain competitive advantages by developing cost-effective product recovery operations and re-evaluating product design priorities.



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