EXTENDED PRODUCER RESPONSIBILITY AND PRODUCT TAKE-BACK:

Applications for the Pacific Northwest

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Background and Acknowledgments

As we enter the new millennium, the citizens of The Pacific Northwest face a number of important environmental challenges. For example, they know that a majority of streams fail to meet water quality standards and that many salmon stocks are listed as threatened or endangered regionwide. In addition, the recently published Oregon State of the Environment Report identified a number of areas where Oregonians can expect continued problems under current policies and programs including: poor water quality (especially in urban and agricultural areas), inadequate water supplies, loss of wetlands, degraded riparian areas, depleted fish stocks, invasion of exotic species, diminished biodiversity, increasing waste and toxic releases, and effects of global climate change. Similar problems are sure to exist in Washington State.

These types of environmental issues threaten to constrain the economy and quality-of-life of communities throughout the region. They also tend to disproportionately affect jobs, public health and quality-of-life in low-income communities and neighborhoods. The public and decision makers want to take appropriate steps to resolve these problems, but often hesitate because they fear the economic consequences will be too severe.

In the spring of 1999, The Center for Watershed and Community Health (CWCH), a research institute in the Mark O. Hatfield School of Government at Portland State University, initiated a project to help the public and decision makers throughout the region better understand the economic and jobs issues associated with developing a more environmentally sustainable economy. The PSU CWCH seeks to provide accurate, objective, and easy-to-understand information about the potential costs and benefits associated with adopting practices and policies that can resolve pressing problems such as endangered salmon and lead to a more environmentally efficient economy. The PSU CWCH has developed collaborative research partnerships with a number of academic institutions in Washington and Oregon, provides grants to a number of leading economists and completes its own research to accomplish this goal. This assessment is one in a series of reports being produced as part of this effort. The project is an integral part of PSU CWCH's focus on developing new, more effective and efficient approaches to environmental governance.

Authorship

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Introduction

This report examines the principles, practices and policies of Extended Producer Responsibility (EPR) and "product take-back" programs, and their potential application to the Pacific Northwest. EPR is an emerging principle for sustainable development that encourages producers to design their consumer products and delivery systems to keep waste and hazardous materials out of the waste stream. At its core, EPR focuses on the responsibility that producers have for the waste and environmental impacts their products generate at the end of their life-cycle.

We have examined EPR to determine the degree to which product take-back policies and practices can contribute to the development of an environmentally sustainable regional economy. The search for new approaches to sustainability is driven, in part, by the fact that the region is struggling to conserve energy and water while restoring endangered salmon and other ecological systems at the same time that pollution and waste are growing at, or above, the rate of economic and population growth. For example, in 1992, when the population was 2,979,000 and the Gross State Product was $63.3 billion, Oregon generated 4,986,401 tons of pollution and waste, which equates to 1.67 tons per capita. By 1996, when the state's population had grown to 3,181,000 and Gross State Product was $94.4 billion, Oregon generated 9,055,794 tons of pollution and waste, or 2.85 tons per capita.[1] Similar patterns are found in Washington State where in 1992 each person generated an average of 2,520 tons of waste, growing to 2,853 tons per capita in 1996.[2] Energy, water and salmon conservation will fail unless the region somehow can reduce its waste and associated environmental impacts.

Traditionally, taxpayers have paid the costs of waste disposal while local government waste management authorities have been responsible for managing the process. The companies that design, produce and sell the products that fill the waste stream for the most part have not been responsible for the costs or management of the disposal stage of their products. As the complexities and costs of waste management have increased, however, existing approaches to waste management and disposal are increasingly being questioned. EPR and product take-back are some of the more promising approaches being pursued to resolve the issues.

The case studies and data assessed in this report suggest that if the proper governance system and strategies are established, EPR and product take-back strategies can save firms millions of dollars annually, increase revenues, and enhance their overall productivity while also reducing costs for taxpayers and reducing waste and environmental impacts. Our hope is that this information offers some assistance to the public and private sectors in the Northwest as they search for new ways to cope with the growing amount of waste and hazardous materials generated in the region.

Overview of the Report

We begin this assessment by discussing the principles and practices associated with EPR and product take-back. We then examine a number of policy approaches and instruments that have been used to promote EPR. This is followed by case studies of selected take-back programs established voluntarily by major U.S. corporations. We conclude with an analysis of the key issues that must be addressed to develop effective EPR policies and programs in the Pacific

Northwest. The appendix includes the information generated from our case studies of both voluntary and mandated take-back programs in nine countries, covering five major industries.

A semi-structured questionnaire was used to collect much of the information discussed in this report. When personal contacts were not available, information was generated from case studies and government and corporate websites. Because EPR programs and policies are relatively new, assessments of their economic costs and benefits were difficult to obtain.

Why The Growing Interest in Extended Producer Responsibility?

The first EPR policy and product take-back program was the Ordinance on Avoidance of Packaging Waste in Germany, in 1991. It required the take-back of packaging waste either by the entity that put the waste on the market or by a nationwide collection scheme in which that entity participated. Since that time, EPR policies and programs have been enacted or are under serious consideration in many industrialized nations including Belgium, The Netherlands, Denmark, Norway, Switzerland, France, Sweden, Austria, Japan, Taiwan, The United Kingdom, Korea, Canada as well as numerous provincial and state governments.

Three major trends explain the growing interest in EPR. First, an increasing number of nations, states and communities are facing a shortage of landfill space. Many western European nations have exhausted almost all available landfill sites. Some eastern U.S. states are running out of suitable landfill capacity, and Lane County, Oregon, and other Northwest communities will soon face similar constrains. This trend has, out of necessity, forced waste management authorities to find alternative methods to dispose of waste such as incineration and source reduction. It has also led to higher tipping fees charged at landfills to dump waste.

Second, the waste stream has become increasing more toxic. As technology grows in importance, pencils and paper have given way to computers and fax machines and other products. These products often contain lead, cadmium and other toxic compounds that generate significant risks to the environment and human health. At the end of their life-cycles, much of this ends up in the waste stream. Incineration can release toxic substances into the atmosphere while landfilling can leach toxic compounds into groundwater and eventually into the food chain.

Finally, the increasing lack of landfill space and complexity of managing the toxicity in the waste stream has made waste management much more expensive. At a time when the budgets of local governments are stretched thin, officials are asking why they should bear the burden for a problem that is not of their own making and about which they can do very little on their own to prevent. In addition, as costs rise, the public is increasingly interested in finding ways to shift the costs of waste management back to the producers that generate the waste. It is for these reasons that interest is growing in many parts of the industrialized world in EPR and product take-back.

Principles and Practices and Extended Producer Responsibility

The concept of EPR and product take-back is not new. It has actually been around for hundreds of years. Before the twentieth century, most Americans produced very little waste. With consumer goods, resources and money in limited supply, everything possible was reused. For example, turn-of-the-century milk and cola distributors who sold their products in glass jars and then collected the jars from the consumer for refilling were practicing what we now call product take-back. Driven by need, take-back programs were the rule, not the exception.

In the last hundred years, however, the historic focus on continual reuse and recycling has been replaced by the mass production of disposable goods, mass consumption, and massive amounts of waste generated on a previously unimaginable scale. The relatively new phenomenon of massive amounts of waste has led to one of the fundamental principles of EPR: producers have a responsibility for the waste and environmental impacts generated by their products. Economists often call this "cost internalization." This principle means that the producers are responsible for unacceptable environmental impacts stemming from market failures that produce "externalized costs." While public-private cost sharing strategies are often used in EPR programs, this principle fundamentally *shifts the burden of responsibility* from government and taxpayers to those that generate the waste in the first place. Perhaps the ideal example of this principle is product leasing. When a company adopts a program to lease, rather than sell its products, the producer never terminates ownership. This allows the producer to maintain control of the product over its entire lifecycle, ensuring the collection of the product before it enters the waste stream, the repairing and reusing of components, and the prevention of environmentally harmful impacts.

Another key principle of EPR is that the most effective way to reduce waste and environmental impacts is to *design out* the problems before they occur, rather than attempting to manage waste and control environmental impacts after they are generated. Thus, EPR places the intervention focus on changes within product design, development, delivery and collection *systems,* rather than on manufacturing facilities and waste disposal methods. This encourages firms to design their products for easy disassembly; to use fewer, lighter, more durable and less toxic materials; and to restructure product delivery and collection systems to more easily recapture end-of-life goods for reuse, remanufacturing and recycling.

These principles underscore that EPR is not aimed at simply encouraging more recycling. Recycling alone can actually perpetuate the production of energy and material intensive products and hazardous materials as industry responds to expanding markets. Instead, the ultimate goal of EPR is to encourage producers to reduce and detoxify material and energy intensity in *every stage* of a product's life-cycle. This emphasis requires that fundamental changes be made "upstream" in the design phase of products and processes. These changes can reduce the "downstream" quantities, costs, toxicity and overall environmental impacts of end-of-life products that enter the waste stream.

The principles of EPR have helped a growing number of firms adopt successful take-back programs. For example, some electronic equipment manufacturers today have discovered that if they design their products for easy disassembly and remanufacturing, large cost savings or

revenues can be generated by collecting end-of-life products from customers and refurbishing them for resale, or by reusing parts in new products. Cost savings and increased revenues can be found through the reuse of components, casings, and subassemblies because it is often cheaper to reuse than to produce from virgin materials. These firms have found that as more of a product is reused or recycled, less bulk and toxic materials enters the waste stream.

Approaches to EPR Policy Design

Most take-back programs in Europe and other industrialized nations have been stimulated or established by legislation, or the threat of legislation. In this section we examine some of the approaches to policy development that have been used to accomplish these goals.

There are at least four policy approaches that have been used to promote EPR. The first is physical management, where the producer bears the responsibility for *physically caring for* its products, or used products, or the impacts of the products at the end of their life-cycles. This can be mandated by government, or adopted voluntarily by producers. The second is *economic responsibility*, where the producer covers all or part of the costs for managing waste at the end of its product's life. The third is *liability*, where the producer is held legally liable for environmental damages caused by its product in the production, use or disposal stages. Finally, *information liability* tools have been used, where the producer provides information to the public on the affects on the environment or public health that its product may have during various stages of its life cycle.

Examples of EPR Policy Instruments

A number of different policy instruments have been used to implement the four EPR policy approaches described above. For example:

<u>Voluntary Instruments</u>

- Voluntary Phase-Outs. Consumer awareness and threats of legislation have led some companies to voluntarily phase out certain products.

- Voluntary Product Design Changes. Consumer awareness and threats of legislation have led some companies to voluntarily redesign their products for better recyclability and reduced toxicity.

- Voluntary Agreements Linked with Mandatory Regulations. At times, government mandates can be linked with voluntary actions. For example, The Netherlands Packaging Covenant of 1991 included voluntary agreements to recycle a minimum of 60% of used packaging that could not be reused and to recycle 75% of the plastics.

Economic Instruments

- Deposit Refund Schemes. These seek to encourage product reuse. Oregon's bottle bill is an example.

- Product Charges. These are used to influence the type of material used in a product and thus seek to change the behavior of consumers. For example, Belgium has introduced a tax on PVC to shift consumption away from the product because it generates toxic by-products in the manufacturing and disposal stages and is impossible to recycle to its original material state.

- Advance Disposal Fees. These are used to cover the costs of disposing of used products. They may be paid by producers into a fund that is earmarked for specific uses such as environmental cleanup. The consumer may not be aware of the fee. Alternatively, the funds can be offered to consumers if they handle end-of-life products in a certain way. For example, Sweden has an advanced disposal fee on cars and Austria has one on refrigerators. The refund may be more than the original fee to create an added incentive to the consumer to return the used product to a specific location and keep it out of the waste stream.

- Virgin Materials Taxes. These seek to discourage the use of certain metals or minerals or old growth wood.

- Removing subsidies for virgin materials, which eliminate perverse incentives for their use.

- Product Procurement Policies. These seek to generate markets for products produced in an environmentally sustainable manner through design and content requirements.

Regulatory Instruments

- Mandatory Take-Back. These require producers to collect end-of-life products before they enter the waste stream.

- Minimum Recycled Content Standards. These dictate the amounts of recycled materials used in products.

- Energy Efficiency Standards. These mandate specific levels of energy efficiency in products.

- Disposal Bans And Restrictions. These restrict specific products from entering the waste stream.

- Material Bans And Restrictions. These restrict specific types of materials from entering the waste stream (e.g. mercury, cadmium, hexavalent chromium).

- Product Bans And Restrictions. These limit the production and use of specific products.

The choice of policy approach or instrument depends on the product of concern, its environmental impacts, and the practicalities of applying an approach to product categories. With this information as a backdrop, we investigated a number of government mandated product take-back programs.

Assessment of Selected Take-Back Policies

Industrialized nations have used one or more of the policy approaches described above to require or promote EPR. In this section we examine a few of these policies including:

- The EU Directive on Waste from Electrical and Electronic Equipment as well as electronics take-back policies in The Netherlands and Switzerland.

- The Consumer Packaging take-back policies of Germany, The Netherlands, Sweden, France.

Case studies of the European Automobile End-of-Life Vehicle take-back policies and The North American Nickel Cadmium Battery take-back program can be found in Appendix I of the report.

Tables I and II provide an overview of selected international take-back policies.

Electronics and Electrical Equipment Take-Back Policies

The EU Directive on Waste from Electrical and Electronic Equipment: This policy aims to address a perceived crisis related to the growing amount and toxicity of waste electrical and electronic equipment (WEEE). In 1992, 4-6 million tons of WEEE was generated in the EU and in 1999 the estimates were 5.4 to 6.7 million tons. To resolve these problems, the EU directive seeks to promote changes in the design of electrical products so that they are composed of less toxic materials and can be more easily repaired, upgraded and reused, or at least disassembled and recycled in a safer manner.

Outcomes of the Mandated Vehicle Take-Back Program

As part of proposed legislation that requires European automakers to take-back unwanted automobiles from consumers, companies have voluntarily agreed to design cars that are 95% recyclable by the year 2015, up from 75% in the past. The benefits are already being realized due to design changes to 2000 model cars such as the Ford Focus which is 85% recyclable and is designed for quick and easy dismantling. Without the threat of legislation, it is highly unlikely that auto manufacturers would have made these design changes.

The directive established compulsory targets for collection by 2006. Between 70% and 95% (by weight) of all collected equipment is to be recycled or reused. Incineration for the purpose of energy recovery is allowed for 10%-30% of the remaining waste. The initial draft directive prohibited the use of mercury, cadmium, hexavalent chromium and brominate flame retardants in all electrical goods by the year 2004. Producers must label equipment to identify plastic types and the location of all hazardous substances in order to enhance recycling and consumer awareness.

The directive places the full financial responsibility on producers to set up and operate collection systems and requires that distributors offer to take back the products they sell, as well as similar products, free of charge. EU member states must collect information from producers on an annual

Table I. Waste Electronic and Electrical Equipment (WEEE) Policy Matrix

Measurement Criteria	Denmark	Germany	The Netherlands	Norway	Switzerland
Regulation Name (effective date)	Order #1067 on Mgt. Of Waste from Electrical and Electronic Products (1997)	Draft Ordinance Concerning the Disposal of Information Technology Equipment	The Disposal of Brown and White Goods Decree (1998)	Regulations Regarding Scrapped Electrical and Electronics Products (1999)	Ordinance on the Return, Taking Back and the Disposal of Electrical and Electronic Appliances (1998)
Authority	Ministry of Environment and Energy	Federal Minister for the Environment, Nature and Nuclear Safety	Ministry of Housing, Spatial Planning and Environment	Ministry of the Environment	Swiss Agency for the Environment, Forests and Landscape
Products Covered	All products dependent on internal or external power supply	All IT equipment	Household appliances, IT, stereos, hot water and heating equipment telecom equipment	All products reliant on electrical current for function	Entertainment, IT, telecom equipment, household appliances
Products Excluded	Batteries, refrigeration products (covered separately)	Toner and print cartridges, CDs	N/A	Batteries, refrigeration products (covered separately)	N/A
Financial Responsibility	Municipalities/ taxpayers	Manufacturers, importers and distributors	Manufacturers, importers	Manufacturers, importers	Manufacturers, importers, distributors
Recovery Responsibility	Municipalities	Municipalities	Producers and municipalities	Producers and municipalities	Producers and municipalities
Recycling Targets	Not specified	Not specified	45-75% depending on product type	100%	100%

Source: http://www.eorm-rtis.com/sampden.htm

basis about the quantity of equipment placed on the market (by numbers and weight). This data will be given to the EU Commission by 2003 and every three years after that.

Netherlands Electronic Scrap Take-Back Program. The Dutch program places almost complete responsibility for electronic take-back on manufacturers and importers of electronic products. It bans the landfilling and incineration of consumer electronics and large appliances (freezers, refrigerators). It set ambitious take-back goals of 100% by the year 2000. The legislation allows industry to impose a surcharge on new products to fund the take-back programs. One result was that in 1997, the Dutch Association for Information and Communication Technology, a trade association, established its own voluntary national take-back program for its members in anticipation of the government's decree.

Switzerland's Electronics and Electrical Equipment Take-Back Program. Due to the rising volume of waste electrical and electronic equipment, and the failure of voluntary efforts, in 1998 the Swiss government required retailers, manufacturers and importers to take back all electrical and electronic equipment free of charge and to treat it in "an ecologically sensitive" manner. The Swiss estimated that 110,000 tons of electrical and electronic equipment were being discarded annually. Voluntary take-back efforts had failed due to problems with free riders (companies that did not participate and thus had lower costs). The policy applies to all products, regardless of when they were purchased (new sales or 15 years ago). Manufacturers have to take back only their own brands, but retailers have to accept any type of product they sell. The government did not set recovery targets (requiring all products to be recovered) and left it up to manufacturers to figure out how to finance their programs.

Consumer Packaging Take-Back Policies

The Germany 1991 Ordinance on the Avoidance of Packaging Waste: This ordinance sprang from the perceived crisis related to lack of landfill space. It led to the adoption of similar policies in The Netherlands, Austria, France, Belgium, Luxembourg, Spain, Portugal and others. Some of these nations spread the costs of these policies among local authorities, consumers and producers. Germany's policy, however, made manufacturers and distributors responsible for the full costs of the consumer packaging they create. The German ordinance is implemented by setting government mandated targets for recycling and beverage container refilling. The mandated targets have increased over time. For example, in 1999 the targets were 75% of glass, 70% of tin, 60% of aluminum and cardboard, paper and composites (by weight). The recovery rate today is about 65%, which puts Germany at the top in terms of recycling rates among EU members. Retailers are required to place bins in their stores so that customers can leave outer packaging at the store. Free riders remain a problem as does the lack of consumer education that deters full participation by consumers. Under pressure from retailers who objected to this mandate, a consortium of 600 companies was formed to license and collect products produced by participating firms. The products are given a Green Dot to identify them to consumers. Over 75% of all packaging in German stores today carries the Green Dot label. Consumers pay increased prices for Green Dot packaging to cover the costs of take-back. This has given manufacturers an incentive to reduce packaging quantities and toxicity which lowers costs and allows them to remain competitive.

Table II. European Consumer Packaging Take-Back Policy Matrix

Measurement Criteria	Germany	Netherlands	Sweden	France
Producer Responsibility Organization	Duales System Duetschland (DSD) 1991	Committee on Packaging and the Environment (CPE) 1991	Reparegistret (REPA) 1994	Eco-Emballages 1993
Collection method	Curbside	Curbside	Consumer collection sites	Curbside
Financing responsibility	Producer	Shared	Producer	Producer
Subsidies to:	None	None	None	Municipalities, guaranteed rates for recycled products.
A. Factors behind implementation	Scarce landfill capacity and increasing per capita waste amounts	Scarce landfill capacity and increasing per capita waste amounts	Scarce landfill capacity and increasing per capita waste amounts	Scarce landfill capacity and increasing per capita waste amounts
B. Costs to public sectors, consumers, corporations	OECD estimates 700DM/tonne of municipal waste in 1994. (US$ 403)	N/A	US$3900/tonne	N/A
C. Assessment of effectiveness[1]	Recovery rate is 65%. Germany enjoys the highest recycling rate in the EU- 63%.	Recovery rate-55% Recycling rate-55%	Recovery rate-73%[2] Recycling rate-58%	Recovery rate-54% Recycling rate-40%
D. Barriers to success	Costs of free riders estimated at DM 400m in 1995. Consumer education.	Consumer education.	No curbside pickup. Collection centers are not accessible enough. Consumer education.	No incentive for structural change. Consumer education.
E. Recommended improvements	Reduction in incineration allowances.	Increased involvement of consumer organizations. Better monitoring of transfrontier waste movement.	See above barriers. Lower costs associated with program.	Reduce reliance on incineration and introduce market forces for upstream design changes.

[1] From European Recovery and Recycling Association, http://www.integra.org.uk/about/erra.html 1997 data.
[2] 1999 data from Swedish EPA http://www.internat.environ.se/document/press/2000/p000606.htm.

The *Netherlands Consumer Packaging Take-Back policy* shares the costs among producers, municipalities and the national government. As with the German, Swedish and French programs, it was created due to the perceived crisis related to the growing amount of packaging waste and scarce landfill capacity. The recovery rate in the Netherlands is 55% as is the rate of recycling. Due to their take-back policy, the rate of recovery of packaging in Sweden is 73% and the recycling rate is 58%. The producers bear the costs for the program here. The Swedish government claims that the lack of accessible collection centers, lack of consumer education, and lack of curbside pickup prevents the program from being more effective. The French packaging policies place the responsibility for take-back on the producers, although subsidies are provided to municipalities to manage the program. The recovery rate in France is 54% and the recycling rate is 40%. The major problem seems to be the lack of incentive for making structural changes in product design, delivery and collection systems.

Summary of Economic and Environmental Costs and Benefits

Because of their relative youthfulness, it is difficult to assess the economic costs and benefits of take-back policies. It appears as though policies that establish a financial incentive for product design changes generate the greatest benefits. A good example can be found by comparing the French and Dutch consumer packaging mandates. The French program requires producers to join an organization that subsidizes the collection of the waste by municipal authorities. However, low landfill tipping fees have failed to give producers an incentive to reduce packaging content. The quantity of packaging waste ending up in landfills has consequently not been reduced.[3] On the other hand, the Dutch program imposes taxes on the packaging manufacturer according to the per-unit weight and the composition of the packaging. Hence, the more that economic incentives are built into mandated take-back programs, the more likely they are to succeed.

In terms of the overall costs or benefits to society, studies with different methodologies and assumptions end up with widely divergent conclusions. An example is the discrepancy in estimated costs between the German and Swedish consumer packaging programs. A recent study by professor Marian Radetzki at Lulea University of Technology in Sweden claims that the total cost to society for the recycling of packaging waste amounts to U.S.$3,900/ton. However, a 1994 study by the Organization for Economic Co-operation and Development (OECD) of the German Green Dot system calculated that recycling packaging costs are around DM700 or U.S.$403/ton.[4] This huge discrepancy indicates the difficulties in comparing studies conducted with disparate methodologies.

Similarly, lack of cost-benefit data from the government agencies that administer mandated take-back programs makes it difficult to assess the costs to the public.

Nevertheless, the fact that an increasing number of national and local governments in Europe, Asia and elsewhere are adopting take-back policies suggests that they believe the programs already are cost effective or will be over the long run. More research is required to fully understand the economics involved.

The environmental data we found suggests that while there were start-up problems, many of the European take-back policies today are producing environmental benefits. For example, Germany's packaging ordinance originally generated a huge amount of recyclable waste that initially had to be exported or dumped in developing nations. Today, however, the ordinance has reduced per capita packaging use, from 94.7 kg in 1992 to 83.2 kg in 1997. The 13% drop compares to a 15% increase in per capita packaging use in the U.S. over the same time frame. In addition, the proportion of refillable beverage containers sold in Germany has increased. Packaging used in the transportation industries has seen the largest reduction by developing reusable shipping containers. The original German packaging ordinance specifically prohibited incineration, but this was changed in 1998 to allow energy recycling under strict conditions that waste must be used as a substitute fuel and not simply as a waste disposal method. While there are 57 incinerators in Germany today, only 2-3 can fulfill this requirement.

However, more long-term research is needed to determine the EPR policies lead to product and process designs that actually reduce the quantity and toxicity of waste over the long term. For example, research is needed to determine if the WEEE policies will extend the use and reuse of electronic products (thus reducing the production of toxic, material and energy intensive products) or simply to lead to more recycling (which may perpetuate the production of resource intensive and toxic products).

Case Studies of Voluntary U.S. Corporate Take-Back Programs

Although most European take-back programs were initiated by government legislation or the threat of legislation, the few major take-back programs that exist in the U.S. have been adopted voluntarily by major corporations. In this section we examine a number of voluntary U.S. product take-back programs. More information can be found in Appendix II of the report. All of the case studies we looked at reported that they broke even or found significant cost savings as well as environmental benefits from their programs. This is particularly true with original information technology equipment manufacturers. Asset recovery and remanufacturing has become an essential part of the business strategy of many of these firms.

Our analysis uncovered a number of key drivers of successful voluntary corporate take-back programs. We also found a number of barriers that constrain program success. These are outlined in Table III. Perhaps the most important drivers are the *economic benefits* resulting from the residual value of the equipment that is recaptured for reuse and the ability to use product take-back as a marketing tool, and the desire to be better *environmental stewards*.

The Benefits of Voluntary Take-Back Programs

Companies can add significantly to their bottom line by initiating take-back programs. Kodak began its camera take-back program for environmental stewardship reasons, but has since found that it saves the company millions of dollars. Companies like Xerox and Dell utilize leasing strategies to secure a steady stream of returned equipment for remanufacturing and resale. Xerox estimates that cost savings from equipment remanufacture and parts reuse was approximately $200 million in 1998 alone. In addition, as a result of this strategy 145 million pounds of waste was diverted from entering landfills, reducing the company's disposal costs.

Economic Benefits: Five of the seven companies we interviewed for this assessment stated that a key driver for the development of their programs was the potential cost savings, and business or marketing benefits the programs could achieve. To make a program financially viable, the assets being recovered through voluntary take-back programs must have some book or market value. Voluntary take-back programs are most often only found in situations where the returned assets, such as cameras and newer information technology equipment, have non-negligible asset values. To achieve this, companies often initiate product design changes to increase the value of their end-of-life goods. For example, a three-year old computer that is returned to Dell Computers Inc. upon the expiration of a lease has significant book and market values. Dell has incorporated product design changes that make remanufacturing more efficient. Dell's design for disassembly and remanufacturing includes zero insertion force sockets, component labeling, and decreasing the number of screws and parts. This makes disassembly and remanufacturing more economically efficient. In contrast, a ten year old generic computer that cannot be upgraded, requires a half hour to disassemble, and is composed of unmarked parts, has little residual value.

An important characteristic of some of the successful voluntary take-back programs we assessed is their focus on retaining control of their products throughout their entire life cycle. In order to secure a steady stream of valuable returned assets and to maintain quality control, these companies have switched from selling products, to selling product-based services that deliver a desired function to buyers. The leasing or servicizing strategy has reduced costs and added additional profit centers to the business practices of Xerox, Pitney-Bowes and other companies.

Inexpensive, remanufactured components recovered from products at the end of their leases can be used to fulfill warrantees and maintenance agreements on existing product lines. In addition, the seller of the function may be able to profit from the implied, internal interest rate on the lease of the product. Finally, both the buyer and the seller of the product-based function may also realize tax benefits from leasing rather than buying.

It was difficult to obtain exact cost-saving data from the firms we interviewed. However, Saturn Automotive, FujiFilm, Kodak, Hewlett-Packard, Pitney Bowes and Xerox described their cost-savings as either "break even" or "substantial." Pitney-Bowes saved $8.2 million from reused parts in 1998. Xerox saves approximately $200 million a year from their product take-back program.

Take-Back Success Story: Pitney-Bowes Corporation

Pitney-Bowes is a company that has found it extremely profitable to recover end-of-life products from its customers. Pitney-Bowes is a world leader in mail meters and mail systems as well as copiers and fax machines. Asset recovery has been an integral part of their operations for many years, in part because of US Postal Service regulations that require postage meters to be leased and not owned. Therefore, Pitney-Bowes has always had to take-back its leased metering equipment making it easy for them to expand take-backs into other product lines. Pitney-Bowes estimates that total net savings from reused parts amounted to $8,200,000 in 1998.

Environmental Stewardship Benefits: Four of the seven companies we interviewed for this assessment stated that a key driver for their program was a desire to be better environmental stewards. For some, such as FujiFilm, this resulted from a desire to avoid criticism stemming from the waste previously generated by their single use cameras. For others, such as Dell Computers and Hewlett-Packard Company, being good environmental stewards has been part of company standards for years.

The commitments these companies have made to the environment appear to be impressive. Saturn now retrieves 10% of replaced bumpers, FujiFilm collects more than 100% of the "single use" cameras they sell (the excess are imported cameras), Kodak recovers and reuses 90% of their cameras (by weight), and Hewlett-Packard processes 3.5 million pounds of product per month and sends no recovered materials to landfills. We could not obtain environmental data from Xerox, Pitney-Bowes, or Dell.

Table III. U.S. Corporate Voluntary Take-Back Program Matrix

	Saturn Automotive	FujiFilm	Kodak	Dell	Hewlett-Packard	Pitney-Bowes	Xerox
Factors encouraging adoption of Product Take-Back Program	Environmental stewardship	Environmental stewardship	Environmental stewardship and cost savings.	Marketing tool.	Cost savings, customer satisfaction, and business development	Cost savings.	Environmental stewardship
Economic Assessment	"Cost Savings"-exact figure N/A.	"Economically Beneficial"-exact figure N/A.	"Substantial"-exact figure N/A.	Viewed as an essential part of its sales strategy and is financed by sales of new units-exact figure N/A.	Break-even on demanufacturing segment.	1998 savings from reused parts was $8.2 million	Approximately $200 million a year.
Assessment of effectiveness	Retrieving 10% of replaced bumpers	110% of cameras sold are returned. (excess is imported cameras)	90% of camera by weight is recovered and reused.	Dell feels its service is being underutilized by its customers.	No recovered materials are sent to landfills.	Products have been improved through remanufacturing process.	N/A
Barriers to success	Technical barriers in the form of paint and other contaminants on the returned bumpers.	Third parties who illegally reload Fuji's cameras.	Third party reloaders and customer participation.	N/A	Ill defined burden sharing among participants.	Expenses associated with parts testing, customer perceptions, sales competition w/ new products.	Customer perceptions.
Recommended improvements	Expand the scope of the take back program.	Closing the environmental loop by recycling retrieved cases into new cases.	Lowering of the legal barriers to the transboundary shipment of waste electronics.	N/A	Above, plus improved reverse logistics.	Delay in ISO 14000 standards governing the use of harvested parts in new products.	N/A

Key Issues and Constraints of Voluntary Take-Back Programs

If product take-back programs are so economically and environmentally beneficial, why don't more producers engage in the practices? Some of the answers can be found by examining the barriers that constrain effective take-back programs.

Based on our interviews and research, it appears as though one of the largest barriers to voluntary take-back programs is the cost associated with *reverse logistics*. This means the collection, sorting and transportation of end-of-life goods to a disposition center for processing. For example, when dealing with cameras that weigh only grams, reverse logistics are simple. However, the logistics of collecting end-of-life autos that weigh tons and cannot be moved easily are much more difficult. Yet, solutions to these problems have been found. Dell and Saturn, for example, use the trucks that haul products to vendors to bring recovered products back to distribution centers. Pitney-Bowes hires a third party contractor to make regional sweeps to retrieve equipment. European packaging and electrical programs subsidize the existing municipal pickup systems. In addition, sophisticated reverse supply chain management computer models are available to help design this process. Whatever method is used, the successful programs attempt to capitalize on economies of scale to reduce per unit collection and transportation costs.

Another obstacle to an effective voluntary take-back program is *consumer bias*. Consumers have shown an aversion to refurbished goods, believing they are inferior to new products. Part of this bias may be due to problems consumers have had with inferior refurbished goods sold by low quality remanufacturers, which are often located overseas. Each of the companies we surveyed said that they subjected all of the refurbish assets to extensive product testing to ensure reliability (e.g. Xerox, HP, Pitney-Bowes, Kodak, etc.). Yet, this often does not convince consumers. Until the bias by consumers can be overcome, a lower demand for remanufactured goods may result in downward price pressures. Lower revenues can jeopardize the long-term viability of any product line. One potential way to address this barrier is to get independent third parties to test refurbished products against new products and to heavily promote the results in terms of quality and durability to consumers.

Still another obstacle to effective take-back programs can be *existing regulations.* For example, the development of the North American rechargeable battery take-back program was hindered by EPA hazardous waste rules that imposed stringent hazardous waste handling procedures on rechargeable batteries. The take-back program was initiated only after Congress passed the Universal Waste Rule in 1996 that excluded rechargeable batteries from hazardous waste handling requirements. Similar problems exist in the single-use-camera industry that is being hampered by the Basel Ban on trans-national shipments of hazardous wastes. Because some cameras contain flash batteries that are considered hazardous waste in some countries, manufacturers are unable to consolidate the collection and demanufacturing of these cameras despite the fact that the cameras contain non-hazardous alkaline batteries. In Europe, the inability to combine multiple national programs into regional programs increased per unit recovery costs and hurt the economic viability of the operation. To resolve this problem governments must be responsive to industry desires to establish take-back programs. The problems with the Universal

Waste Rule resulted in significant quantities of cadmium entering the waste stream that might have been diverted under the take-back program.
Concerns about *free riders* are also a barrier. Firms are often wary about being required to adopt new practices or charge increased fees if competitors can somehow avoid these costs. Government must ensure a level playing field for all sectors and firms within an industry for EPR policies to succeed.

Finally, inappropriate *subsidies* for the mining, production and use of virgin resources can create major barriers. Outdated or poorly planned subsidies make it appear that virgin materials are cheaper to use than reused or recycled feedstocks. However, the cost differences are usually related to the fact that many direct and indirect costs have been transferred to the public rather than being borne by the developer (i.e. they have been "externalized'). When the true costs are externalized rather than being borne by the actual producers, inaccurate price signals are sent through the economy of the true costs of product development, use and disposal. This undermines the effectiveness of EPR programs.

Key Issues For EPR Policy and Program Design in the Pacific Northwest

Based on our research, it appears EPR policies and programs could make a significant contribution to the development of a more environmentally sustainable economy in the Pacific Northwest. To accomplish this, however, a number of technical, practical, market related and political issues must be resolved.

Technical Design Issues: If EPR policies are to be adopted in the Pacific Northwest, one of the first issues that must be resolved is the desired outcome of the policies. Is the goal to encourage producers to redesign and detoxify their products? Is it to encourage producers to manage their products at the end of their life-cycle? Is it to shift the costs of waste management to producers as a way to reduce costs or generate increased revenues? Is it to save scare landfill space or keep hazardous materials out of the waste stream? The answers to these questions will lead to different types of policy approaches and instruments.

A related question is whether or not EPR policies are the best way to achieve the chosen goals. One could argue, for example, that if the goals of EPR policies are to save increasingly scarce landfill space and to keep hazardous materials out of landfills, these problems could be better resolved by either using market mechanisms (e.g. simply raising the costs of landfilling) or by banning certain products or hazardous materials in consumer products. For example, the use of aluminum in single use (disposable) drink cartons, as well as PVC and heavy metals such as lead, mercury and cadmium in many products generates hazardous emissions throughout a product's manufacturing, use and disposal stages. Banning these substances could be a more effective and safer method for preventing the release of these substances into nature. Before enacting EPR policies in the Northwest, information is needed to demonstrate that EPR policies are a more effective way to address these issues than market mechanisms or product/substance bans.

Another key issue is the question of which parties are actually the "producers." Many consumer products are composed of numerous parts produced by different manufacturers that are

assembled and sold by yet another company. Many others are assembled overseas and imported. Still others may be upgraded or reconditioned and put back on the market (e.g. upgraded computers). In these cases, who exactly is the producer? The question of which parties are responsible must be resolved before any effective policy can be designed.

The issue of who should pay for the collection and recovery of products is an important one. The funding strategy will be closely related to the determination of the parties responsible. For example, will the program be funded by deposits paid by consumers; by mandatory contributions by producers to escrow accounts when a product is placed on the market; by some type of legally binding guarantee from the manufacturer or importer to handle take-back; or by some other method? One strongly held view in Europe is that the last consumer should be able to return end- of-life products at collection facilities free of charge. Otherwise, few people will take the effort to return end-of-life products. When this principle is followed, the original consumer, manufacturer or importer must pay the costs. It will be important to review the history and success of deposit schemes such as those related to the Bottle Bill in Oregon to determine the funding strategy most likely to succeed in the Pacific Northwest.

The type of waste diversion allowed under a policy is also a key issue. Will producers be able to collect end-of-life products and ship them overseas to countries with few environmental policies and cheap labor forces? Will they be required to treat the products domestically? The answers to these and other similar questions will go a long way to determining the economic, social and environmental consequences of EPR policies.

The measurement system used to determine the success of EPR policies will be vital to their development. How will government know if policies are achieving their intended outcomes? One approach is to set collection and recovery targets. Yet, at least in the early going of new policies, it is often difficult to know what targets may be achievable. In addition, if targets are set, local, regional and even national databases must be developed. This, in turn, will mean that government must require that manufactures or their trade associations keep detailed records. This may not only add additional costs, but unless some standard protocols are adopted, it may lead to different measurement systems and reporting requirements between government units and the private sector. This question deserves considerable thought.

Consumer Participation Issues: Lack of effective consumer education is a significant barrier to successful product take-back policies. Nearly every take-back program that relies on consumer participation to succeed, reported unsatisfactory consumer education on recycling and environmental issues as a major barrier. For example, due to lack of knowledge and other factors, consumers do not adequately recycle nickel cadmium batteries in the U.S. in spite of established take-back policies and programs and do not participate in free computer take-back programs when offered in Europe. On the other hand, Oregon has had ample success with returns related to the Bottle Bill. Consumer education is a complex, costly process that requires continual effort. Before any EPR policies are adopted in the Northwest, carefully developed and well-funded consumer education programs will be needed.

Market and Competitiveness Issues: The oversupply of, or lack of demand for, recycled goods that may arise from successful EPR policies are significant barriers that must be addressed before any effective policies can be developed. Take-back policies can create a glut of recycled products flooding the market at once. An oversupply can cause a decline in market prices hampering asset recovery efforts and effectively lowering the residual value of the recovered product. This happened in Germany in the early 1990s when its Green Dot packaging program created tons of surplus plastic that had to be exported or stored due to a lack of domestic processing ability for this commodity.[5] Germany later changed the provisions of the program to allow for more incineration instead of recycling. Although European take-back policies for computers and electrical equipment are still in their early stages, it is possible that a similar outcome could occur here as well. There are policy options to address this issue. For example, the French packaging program ensures recyclers a guaranteed price for their products. Other strategies have focused on increasing the market demand for these goods by offering research grants and subsidizing the development of reused, remanufactured and recycled goods markets. It will be vital to know that markets exist for collected products before enacting any major take-back policies in the Pacific Northwest.

In addition, some industries that produce consumer goods for worldwide markets have argued that the European policies create an uneven playing field. They claim that having to produce products in one manner for the European markets and in another manner for other markets may drive costs up so high that some producers are forced out of business. The data does not seem to support these claims so far, however, as we could find no evidence that firms have gone under due to the European policies.

However, EPR policies could place small and mid-sized producers and importers at a competitive disadvantage in the Pacific Northwest. Larger firms may have the technical knowledge, local infrastructure and financial and human resources needed to successfully navigate the complex regulatory waters created by EPR policies, while small or fledgling firms or importers without those resources may not. Great care must be given to design technical and financial assistance programs to ensure that EPR policies do not end up favoring large producers over small firms or importers.

European take-back policies may also be creating a competitive disadvantage for U.S. firms due to the increasing sophistication that European firms involved with product take-back are developing compared to their U.S. counterparts. The OECD notes that "…significant refinements have been made in all recycling technologies as a result of increased recycling requirements under the Packaging Ordinance…"[6] Industries such as auto dismantling and plastic recycling are receiving considerable attention and investment because Europeans view recycling as an important source of jobs for low skilled labor working for certified recyclers. Clean Production Action, an environmental training organization, notes that recycling one million tons of solid waste leads to 1600 jobs, landfilling the same waste leads to 600 jobs, and incinerating the waste leads to only 80 jobs.[7]

In addition, since the U.S. is not a party to the Basel Ban, the U.S. exports tons of waste electrical and electronic equipment (WEEE) to developing countries such as India each year for demanufacturing by low wage labor. As parties to the Ban, European states have had to develop

an infrastructure to demanufacture and recycle these hazardous goods while the U.S. continues to export its waste to nations with low labor costs. The increased investment in product take-back systems in Europe could lead to a competitive disadvantage for U.S. companies should the move towards environmental stewardship and sustainability in this country continue to accelerate.

Finally, despite the potential for creating competitive disadvantages, many Northwest firms export goods to Western Europe and Asia. These firms must maintain their ability to compete by changing product design, delivery and collection systems to respond to take-back regulations in these locations. This fact alone should encourage government to assist Northwest firms to learn about and apply take-back programs.

Political Issues: Perhaps the most important political barrier to the development of EPR policies in the Pacific Northwest is lack of a perceived crisis. The only national take-back policy in the U.S. was driven by the enactment of policies in a number of states mandating the take-back of Nickel Cadmium batteries by manufacturers. The absence of any other national take-back policy in the U.S. is at least in part due to the fact that a sense of crisis does not exist yet. Many Northwest states still believe that they have sufficient landfill capacity available to meet their waste management needs. In addition, while the majority of streams do not meet Clean Water Act standards and the effects of global climate change are becoming more apparent, there is still no sense of crisis over the disposal of hazardous materials and substances. This is beginning to change, however. A growing number of eastern U.S. states are running out of environmentally safe landfill sites and shifting to incineration to dispose of their waste.[8] Sixteen states have already banned white goods (refrigerators, washers, dryers) from their landfills. Lane County, Oregon, and other regions in the Pacific Northwest are also beginning to find environmentally safe landfill sites an issue and are looking for alternatives.

Finally, the problems related to reverse logistics, consumer bias against reuse and recycled products, the costs to producers of redesigning their products and processes, and the fears of an uneven playing field will often generate opposition to EPR policies from industry in the region. Some industries have been known to favor "extended stakeholder responsibility" rather than producer responsibility. Governments may have to provide technical and financial assistance, tax relief and other incentives to help producers transition to take-back schemes in order to garner sufficient support from industry to enact effective EPR policies.

Conclusion

Given the extensive land base of the Pacific Northwest, it is unlikely that the majority of communities in the region will soon believe that a crisis is near at hand related to lack of landfill capacity. Nevertheless, the trends described in the introduction of this report can already be observed in the region. For example, concerns are rising about the availability of landfill sites that will not harm habitat for species listed under the Endangered Species Act, or add to pollution in Water Quality Limited streams. There is also growing concern about the increasing toxicity of the waste stream and the potential for the leaching of hazardous materials into groundwater and the food chain. Between 1997 and 2004, over 315 million computers will have become obsolete in the U.S. alone, representing up to 1.2 billion pounds of lead and many other toxic compounds

entering the waste stream.[9] Finally, there are increasing concerns about the level of financial and management responsibility local communities should bear for waste disposal and about the rising costs associated with managing the waste stream. These trends are likely to generate increased support for some type of ERP policies or landfill bans for hazardous products such as electrical equipment and white goods.

Changes are already occurring here. A decade ago few major product take-back policies or programs existed in the U.S. with the exception of beverage packaging laws, or bottle bills. Today however, voluntary product take-back programs are growing in the information technology industry and are becoming more common in other industries because of the value they add to a business. Support for EPR policies to expand these practices throughout key industries is certain to grow.

EPR programs and policies have already generated significant cost savings for some firms and a number of industrialized nations claim that EPR policies generate environmental benefits and savings for taxpayers. If the design, market and political barriers discussed in this report can be resolved, it appears as though EPR policies and practices can make a major contribution to the development of a more environmentally sustainable regional economy while also saving companies and taxpayers potentially millions of dollars.

By outlining the principles, policies and practices of EPR, and by examining a number of policy and company case studies, we hope this report provides a platform for further examination of the potential application of EPR and product take-back programs in the Pacific Northwest.

Appendix I

TAKE-BACK POLICIES BY PROGRAM AND COUNTRY

END-OF-LIFE VEHICLE (ELV) TAKE BACK POLICIES

German ELV Take-Back Policies

German and importing automakers agreed to a voluntary take-back initiative in 1996. The voluntary pledge includes setting up an infrastructure of certified dismantlers, recycling end-of-life vehicles from their last owners free of charge, and goals for the reduction of auto shredder residue (ASR) sent to landfills from 25% currently to 5% by 2015. Included in the agreement is the requisite re-design of autos to be recycled and reused more readily according to design for recycling criteria.

A. Factors Behind Implementation

German automakers were responding to proposed legislation by the German government that would have held manufacturers explicitly responsible for their products. In addition to imposing strict take-back requirements for ELVs, the German "scrap car rule" would have mandated recycling and reuse quotas. The rule also required automakers to incorporate eco-design schemes to facilitate ease of dismantling and identification of recyclable components creating a genuine whole-vehicle feedback loop.

B. Costs to Public Sectors, Consumers, Corporations

By agreeing to develop an industry sponsored operating procedure, carmakers avoided a potential onerous regulatory burden.

C. Assessment of Effectiveness

The agreement has been criticized as it allows for the incineration of Auto Shredded Residue (ASR) for energy recovery prior to going to landfills. This loophole allows automakers to avoid the goals by burning excess ASR.

Netherlands ELV Take-Back Policies

The Dutch take-back system for ELVs evolved from the German scrap car rule. Carmakers, working in concert with the government, have developed a system of recycling cars through coordinated efforts of auto dismantlers, collectors and recyclers.[10] The Auto Recycling Nederlands (ARN) system is funded by a waste disposal fee of 150 NLG on new automobiles sold and on any imported autos. Owners of ELVs consequently do not have to pay for the disposal costs associated with their autos. Targets for recycling range from 86% in 2000 to 95% by 2015.

A. Factors Behind Implementation

Similar legislation in Germany and France led to the development of the ARN. Concern over the availability of landfills to deposit auto shredder residue (ASR) is a motivating factor in all European ELV activity.

B. Costs to Public Sectors, Consumers, Corporations

The burden for the funding of ARN falls entirely on the purchasers and importers of new automobiles. The 150 NLG waste disposal fee generated over 97 million NLG income in 1999 while total expenditures for the program were only 49 million, generating 57 million toward the reserve fund which now contains 309 million NLG.

C. Assessment of Effectiveness

The program appears to be highly effective compared to countries without ELV systems. Compared with the 75% recycling rate (by weight) of ELVs in the U.S., the Dutch program expects an 86% rate in 2000, the target set by the auto industry. Similarly, 89% of all ELVs entered the ARN program in 1999 totaling 251,943 vehicles.

D. Barriers to Success

The shift towards more plastics and polymers in new vehicles has made recycling more difficult. Similarly, the increase in the incidence of airbags, seatbelt tensioners and air conditioners will result in higher dismantling and regular costs.

E. Future Improvements

Although the industry has set an ambitious goal of 95% recyclability by 2015, the program allows 10% of the recycled amount to be achieved through incineration with energy recovery. Barring changes in vehicle design that would facilitate greater recycling content, apparently the only way to meet the targets is by incineration.

French ELV Take-Back Policies

The French system focuses on improvements in car design and dismantling tools for the existing labor intensive, manual-dismantling approach as opposed to the German and Dutch approach, which incorporates mechanized dismantling.[11] The French government views the auto-dismantling sector as an important source of employment for unskilled labor in France.

A. Factors Behind Implementation

The French posit the motivating factor behind the adoption of the Agreement on the Treatment of End of Life Vehicles was the government's lead in coordinating EU policy on priority waste streams. French car manufacturers and importers responded to the threat of legislation and the "threat" posed by the German approach.

B. Costs to Public Sectors, Consumers, Corporations

The goal of the Agreement was to increase the recyclability of French automobiles. The costs of redesigning autos to increase the ease of dismantling, sorting according to ISO 14001 labels, and choosing recycling friendly materials have yet to be quantified. The most obvious costs have fallen on the dismantlers and shredders who have decided to become certified. The large cost associated with certification (400-1.5m FF) makes the return on investment questionable.

D. Barriers to Success

The French certification program for ELV dismantlers has been running behind schedule. As of 1996 only 3-4% of dismantlers were certified. Insurance companies and dealer networks have stated they will only deal with certified auto dismantlers and shredders. Until a critical mass of certified dismantlers and shredders is developed that will enable insurance companies and dealers to ensure environmentally sound disposal of cars, the system will not operate as planned.

EUROPEAN CONSUMER PACKAGING POLICIES

Consumer packaging waste represented approximately one third (by weight) of the German municipal solid waste stream in 1991.[12] Given the scarce disposal capacity available to European countries, it is no surprise that one of the earliest take-back programs targeted this area. The German Green Dot program, initiated under the Ordinance on the Avoidance of Packaging Waste (1991) mandates that producers and manufacturers of consumer goods are responsible for the costs of managing packaging waste after consumers are done with it. In most countries, industry must pay for the collecting, sorting and reuse or recycling of these materials. The systems are financed by fees on packaging according to material composition and weight and is paid for by packaging producers and administered by a producer responsibility organization (PRO). The system originally mandated aggressive recycling quotas for materials without allowing incineration for energy recovery. Without sufficient demand for the recycled products, Germany was forced to export much of its recycled waste.

While most European states have packaging take-back programs, we examined Germany, the Netherlands, Sweden and France. The first three are included because of their importance or controversy, while France is examined due to its relative inefficiency. Germany, The Netherlands and Sweden have the most progressive policies that aim to influence structural change on the firm level. By imposing fees based on packaging weight and composition, firms are encouraged to minimize the weight and volume of individual packages, make packaging be refillable, and use environmentally sound materials. These policies attempt to couple product and waste policies to minimize landfilled material. According to the OECD, the Dutch require use of Life Cycle Analysis (LCA) and Market Economic Analysis (MEA) by packaging producers. This has resulted in many innovative adaptations in packaging but more importantly this process has increased cooperation between all links in a product chain, and results in improved insights into the cost structure of an enterprise.[13]

The focus on source reduction of packaging waste should ultimately be more successful than the method employed by the French. The French system does not rely on LCA/MEA to reduce upstream waste. Instead, its low fees are set by industry and are used to subsidize municipal waste treatment systems that collect and sort the waste. The fees do not cover the full costs of treatment and elimination of waste. In addition, the French rely heavily on waste incineration in its waste policy and this reliance has affected recycling efforts negatively.

WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE) TAKE-BACK POLICIES

End-of-life computers, cell phones, TVs and other electronics have become a major waste management issue in industrialized countries and the problem is worsening. The National Safety Council estimates that by 2007 there will be almost 500 million obsolete computers in the U.S. alone. Coupled with the expanding cell phone market and VCRs made obsolete by DVDs, environmentally sound disposal practices for WEEE should be in great demand. Electronic equipment contains many toxins and heavy metals that leach into groundwater if disposed in landfills and produce carcinogenic dioxins if incinerated. Already, the five or more pounds of lead in computer screens and TVs account for 40% of all the lead in U.S. landfills.[14]

Most of the policies examined here entail the producer being responsible for the collection, sorting and environmentally sound disposal of electrical equipment with the exception of Denmark, which lays the burden on municipal authorities.[15] Given the recent evolution of these policies, environmental and economic assessment of their effectiveness has not been forthcoming. Most of the policies ensure that the consumer will not have to pay a fee to dispose of the equipment. If the consumer is buying a replacement product from a retailer, then the retailer can impose a hidden disposal fee on the old product.

Denmark

Statutory order No.1067 on Management of Waste from Electrical and Electronic Products states that virtually all electrical waste will be collected and treated by local authorities. Collection sites include retailers and central collection sites. The order gives local authorities the main responsibility for recovering WEEE from all sources. The system is funded through local authorities. The estimated total cost of implementing the law is about DKr5 (US$ 0.70) per kilo, equivalent to total costs of DKr104m (US$ 15m). Household waste taxes will rise by DKr50 (US$ 7) per year to help fund recovery.

Germany

Germany has drafted legislation called the Draft Ordinance Concerning the Disposal of Information Technology Equipment (1998) that would cover the take-back of Information Technology (IT) equipment including PCs, photocopiers, printers, scanners and communication equipment. Producers (manufacturers, distributors and importers) must take-back their brand of electronics free of charge from the customer. Producers may charge a fee for equipment sold prior to the enactment date. Municipalities will be responsible for the collection and storage of equipment.

The Netherlands

The Disposal of Brown and White Goods Decree (effective June 1, 1998) requires manufacturers and importers to take back old electrical equipment free of charge when consumers purchase new ones regardless of brand name (until 2005 when producers are required to take-back only their own brands). Retailers take back end-of-life products from consumers and can then sell them or return these items to the municipality, manufacturer or importer. The manufacturer or importer must pay for the cost of the disposal. Municipalities will be responsible for collection from households and suppliers.

Norway

The Norwegian Regulations Regarding Scrapped Electrical and Electronic Products (effective June 1, 1998) require retailers and municipalities to accept waste equipment from consumers free of charge. Manufacturers and importers are held responsible for the collection, treatment and transportation to a certified treatment center for demanufacturing/recycling. Municipalities must accept WEEE from households and can finance this through a levy on waste disposal fees.

Switzerland

The Swiss Ordinance on the Return, the Taking Back and the Disposal of Electrical and Electronic Appliances (effective July, 1998). This ordinance mandates that retailers, manufacturers, and importers take-back end-of-life electrical equipment free of charge from consumers and dispose of it in an environmentally sound way. Consumers can drop off appliances at retailers, a disposal facility, or at an industry collection site. Manufacturers and importers are responsible for the cost of recycling.

NORTH AMERICAN TAKE-BACK POLICIES

The current rechargeable battery program was established in 1995 to collect and recycle batteries in North America. Collection centers have been set up at retail sites, businesses and public agencies, communities and industry recycling centers for consumers to deposit Nickel Cadmium (Ni-Cd) batteries that are shipped to independent contractor recycling facilities. The program is paid for by industry license fees that most major battery and product manufacturers subscribe to.

A. Factors Behind Implementation

The Universal Waste Rule (1995) eliminated some regulatory hurdles to the collection and recycling of batteries that under certain conditions were classified as hazardous waste. The Mercury Containing and Rechargeable Battery Management Act (1996) made the Universal Waste Rule apply to all 50 states and was sponsored by the battery industry which sought to universalize the myriad of state legislation (driven mainly by New Jersey and Minnesota) that required manufacturers to take back rechargeable batteries at their own expense for disposal or recycling. As a result, the battery industry association established the Rechargeable Battery Recycling Corporation (RBRC) to conduct the battery take-back process. Its mandate is to educate the public on battery recycling and to collect and recycle Nickel Cadmium (Ni-Cd) batteries whose cadmium component is toxic to humans and wildlife, and needs to be eliminated from the solid waste stream for environmental reasons.[16]

B. Costs to Public Sectors, Consumers, Corporations

The program is voluntary and is funded by license fees from battery and product manufacturers who join the RBRC and are able to place the RBRC seal on their product. The owner of the brand name on the battery is generally the licensee and the owner of the brand name of the product would be a sub licensee. However, the costs to collect, transport, administrate and recycle the batteries are ultimately impounded into the price of the battery or product and passed on to the consumer. By internalizing the costs of disposal into the purchase price, the burden of end-of-life product disposal shifts from municipalities and solid waste treatment operators to the consumer.

C. Assessment of Effectiveness

RBRC estimates recycling rates of spent Ni-Cd batteries. They estimate that in 1998 25% of end-of-life Ni-Cd batteries were recycled. The industry (RBRC and for profit organizations) recycled 3.7 million pounds of batteries in 1998 in North America, up from 2.7 million in 1995.

D. Barriers to Success

Voluntary programs such as RBRC's could be bothered by free-riders, companies who sell products without paying the license fees. RBRC claims that this is not a major issue, with over 90% of battery manufacturers, resellers and marketers enrolled as licensees in the program. Participation could grow to higher levels as RBRC plans to expand its battery coverage on January 1, 2001 to include Lithium-Ion and Nickel Metal Hydride as well as Ni-Cd batteries.

However, consumer action on recycling issues remains a formidable obstacle. A study paid for by RBRC shows that although 56% of portable product owners know about recycling their batteries, only 16% say they recycle rechargeable batteries.[17]

E. Future Improvements

One proposed improvement for the program is better training at retail stores who are collection centers for the program. Many customers bring the old batteries in to find exact replacements, but end up taking the spent battery home because overworked store employees do not remind them about the recycling bin.[18] Battery deposits are sometimes recommended as a way to increase recycling rates, although automotive batteries have achieved a 95% recycling success rate despite the fact only 12 states have mandatory deposits schemes in place.

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Appendix II

VOLUNTARY CORPORATE TAKE-BACK PROGRAMS

AUTOMOBILE BUMPER TAKE-BACK STRATEGIES

Discretionary take-back policies for U.S. automakers are limited to a relatively small component of an automobile: bumpers.

Saturn's take-back strategy[19]

Saturn's take-back program is managed in-house and is initiated by collecting bumpers at dealerships when independent auto body shop employees come to pick up new parts. The damaged bumpers are transported from dealerships to the factory in trucks that are returning from delivering new cars. The bumpers are processed and reground into new pellets and then sold to auto parts manufacturers for use in mostly non-visible parts production such as wheel wells and heater housings.

A. Factors Behind Implementation
Saturn has a strong commitment to environmental stewardship. This commitment led to the initiation of the program that is designed to reduce landfilled materials.

B. Economic Assessment
Saturn is now finding that it enjoys cost savings from using recycled resins rather than virgin resins. Exact numbers were not available.

C. Assessment of Effectiveness
As of 1996, Saturn was only collecting 15 bumpers per day, amounting to approximately 10% of new bumpers being shipped to dealers for repairs to new cars.

D. Barriers to Success
Technical barriers exist in the form of paint and contaminants that are attached to the returned bumpers.

E. Recommended Improvements
Saturn has yet to involve end-of-life cars into its take-back and recycling network.

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CAMERA TAKE-BACK STRATEGIES

The single use camera industry has developed an extensive infrastructure to reuse and recycle single use cameras. After consumers take the camera to a photofinisher for developing, the cameras are returned to the manufacturers for disassembly and extraction of reusable parts, which include the main unit (circuit board), flash unit, lens and battery. The recyclable parts include the front and back covers; the switch unit and the advance wheel are sent for resin recycling to be used in new cameras or other products.[20]

FujiFilm

Fuji operates a true product take-back program by purchasing its cameras from photofinishers for $.15 each. Fuji also pays for the cameras' transportation back to its Greenwood S.C. plant for sorting, disassembly and reuse. At this time, Fuji reuses the flash, circuits and other components of the camera and recycles the polystyrene cases into other parts. [21]

A. Factors Encouraging Adoption of EPR

The motivation for Fuji to begin take-back of its single use cameras began as an environmental stewardship initiative. Environmental groups were complaining about the impacts of "disposable" cameras and Fuji responded with its camera recycling initiative. Cost savings were realized after the program had commenced and Fuji realized gains from asset recovery. However, we could not obtain data on the cost saving component of the program.

B. Economic Assessment:

The main costs of the program include the purchase of the cameras from finishers, transport to the factory, and costs to disassemble, clean, test, and sort the recovered materials. Prior to the completion of the Greenwood plant, the program was less economically viable because cameras had to be shipped to Japan for disassembly. The revenues associated with the program are not publicly available, but according to the company the program is "economically beneficial."

C. Intangibles

Fuji believes that the single use camera take-back program has contributed positively to the company's experience with product life cycle analysis. By integrating program cost/benefit analysis with environmental stewardship, a flagship program has developed. It has led directly to the creation of the first "inverse manufacturing" plant in the world. At the company's Ashigara factory, robots automatically separate, disassemble, clean, replace parts and reassemble Fuji Quick Snap single use cameras. Another benefit generated by the program is the growth of industry cooperation to support product stewardship. Kodak, FujiFilm and Konica work together to support a dramatic change from what was once considered a disposable camera to a renewable piece of photographic equipment.

D. Assessment of Effectiveness

Currently, Fuji receives back 110% of the cameras it sells in the U.S. Receipts of third party cameras that are returned by finishers to Fuji account for the additional amount.

E. Barriers to Success

Third party "reloaders" corrupt the take-back and asset recovery process. They commonly tape the cameras cases back together after putting in new film. This tape contaminates the recycling stream and adds to the incremental labor costs of reusing the camera. A patent infringement case has been filed by Fuji against these reloaders in an attempt to decrease the importing of third party cameras.

F. Future Improvements

Currently Fuji is not recycling the polystyrene camera cases into new cases. In the near future they intend to close the loop in their manufacturing process by recycling cases back into cases.

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Kodak

Kodak's hallmark example of its design-for-the-environment initiative is its program to recycle FunSaver and other single use cameras. An average of 86 percent (by weight) of all cameras are recycled or reused in the manufacturing of new cameras. As part of Kodak's Environmental Action Program, film processors are asked to return all Kodak One-Time-Use Cameras for recycling.[22]

A. Factors Encouraging Adoption of EPR

Kodak adopted its Single Use Camera (SUC) take-back program for two reasons. First, "disposable" cameras were being criticized by environmental groups, and Kodak felt that the lack of a reuse program would be a barrier to the sale of SUCs. Second, Kodak implemented the program for cost saving reasons.

B. Economic Assessment:

Kodak does not disclose the cost savings associated with its program, but does that savings from remanufacturing are substantial. Kodak reuses nearly all of the camera and is reusing the camera batteries internally or is re-selling them in secondary markets. As a result, over 90% of the camera is being either reused or recycled.

C. Structural Changes

The infrastructure Kodak developed is now being used to return the plastic film containers as well as the metal casing and photo paper cores from Kodak film. Kodak feels that the SUC program has made the entire management team aware of the "win/win" scenario available for both the company and the community with a successful environmental initiative.

D. Assessment of Effectiveness

Kodak has applied Life Cycle Analysis (LCA) to its SUC program to increase recycling levels and to reduce the environmental impact of the product. With recyclable/reusable content over 90% (including the battery), Kodak's cameras are almost fully optimized for material recovery.

E. Barriers to Success

Kodak has identified two main barriers to the program in addition to the third party reloaders identified by Fuji (see below). First, retail photofinishers outside of North America are not participating in the program to the extent desirable. They might be selling cameras to reloaders or merely throwing the cameras away instead of returning them to Kodak at no cost to themselves. The main reason for non-participation is a lack of awareness of the camera take back and reuse program. Second, the Basel ban on international hazardous waste shipments made it impossible to trans-ship the cameras across borders to collection centers because of the alkaline batteries that power the flash in some units. Although alkaline batteries are not considered hazardous waste in the U.S., most European nations do not delineate battery types in their hazardous waste regulations. As a result, many photofinishers in Europe simply dispose of the cameras in the trash rather than contracting with special recycling companies to transport the cameras.

F. Future Improvements

Kodak recently completed an agreement with three Nordic countries and the United Kingdom to allow shipment of its cameras to the UK for collection and remanufacturing. By consolidating its collection centers, Kodak can lower costs of shipping, reduce product cycle times, and achieve economies of scale in its remanufacturing process. The lowering of these regulatory barriers would greatly enhance the effectiveness of the program, as would more extensive education of international photo finishers.

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INFORMATION TECHNOLOGY ORIGINAL EQUIPMENT MANUFACTURERS (OEMs)

Dell Computers

Dell operates a product take-back system similar to Xerox's more heralded operation. Dell offers computers on a lease so that customers don't have to worry about disposal regulations. At the end of the lease, the equipment is returned to Dell to be refurbished or utilized using other asset recovery techniques. In addition, Dell operates a value recovery service that repatriates functional equipment and pays a fair market value to the customer. Dell also offers a PC recycling service intended to pick up non-functional equipment. Dell collects these products from locations that can meet targets for minimum numbers of units and transports them to a disposition center. Units that have economic value are sold to vendors; units with no residual value are recycled by other vendors according to strict statements-of-work. Less than 1% of the non-functional products that Dell receives end up in landfills.[23]

A. Factors Encouraging Adoption of EPR

Dell began the asset recovery service in 1991 long before recycling was fashionable. It did so as a sales tool that enabled Dell to sell to large customers who needed older machines removed after upgrading to Dell machines.

B. Economic Assessment

Dell will not release information regarding the costs associated with its asset recovery service. Dell views the service as an important part of its marketing strategy and its activities are financed by sales of new units.

C. Assessment of Effectiveness

Dell is only concerned that customers are not fully utilizing their service and are storing or disposing of equipment in a non-environmentally sound manner.

D. Barriers to Success

Dell's asset recovery service does not receive any revenue in recovered assets from non-functional equipment. Rather this potential revenue is credited to Dell from the vendor to subsidize future disposal of machines.

Hewlett-Packard (HP)

Hewlett-Packard Company is a market leader in information technology equipment and has been a pioneer in environmental stewardship since the early 1990s. HP has utilized Design-for-Environment practices since 1995 and institutionalized strict green procurement criteria as well. HP does not have a formal domestic take-back program for its retail customers. HP recovers equipment through its trade-in and trade-up programs and through its Unix leasing business segment. In addition, HP has an extensive take-back program for its printer toner cartridges. HP states that they have recycled over 25 million LaserJet cartridges worldwide since the program began, avoiding 31,000 tons of landfilled materials.[24]

A. Factors Encouraging Adoption of EPR

HP initiated its existing take-back program for three primary reasons. First, customers were demanding value for computers and peripherals that they wanted to replace with new units. The HP trade-in program provided customer satisfaction for this marketing segment. Customers who required environmentally sound disposal of their equipment could be assured that their needs would be met by HP's stringent environmental disposal techniques. Second, the trade-in program was a necessary component in HP's business development plan. Finally, HP was able to realize cost savings from the retrieved materials. Valuable or scarce components could be retrieved from newer equipment and remanufactured for sale in new units.

B. Economic Assessment

Like other demanufacturing operations surveyed in this report, HP expressed the belief that environmentally sound treatment of end-of-life equipment is expensive. These products have very little market value with which to offset disposal costs. At HP's Roseville, California demanufacturing site the costs associated with processing end-of-life goods are offset by revenues received from the higher value commercial take-backs from trade-ins and trade-ups to yield a break-even for the facility as a whole. HP's ability to operate at a break-even is, in part, due to its investment in some of the largest and most sophisticated shredding and separation equipment available. With approximately six million dollars invested in this demanufacturing equipment, it is a cornerstone of HP's commitment to environmental goals and achievements.

C. Assessment of Effectiveness

HP's program is very effective according to Renee St. Denis, Environmental Business Unit Manager at HP. The company processes approximately 3.5 million pounds of products a month with none of the recovered materials going to landfills.

D. Barriers to Success

Due to ill-defined burden sharing arrangements between distributors, resellers and manufacturers, HP is not ready for full scale consumer take-backs. The company believes that the responsibility for the costs incurred for product returning, demanufacturing and disposal have not been specified at the point of sale. Placing the burden solely on the HP would not be equitable since value is extracted all along the supply chain.

E. Future Improvements

In addition to clarification of burden sharing for a retail take-back program, HP feels that its program could be improved through regulatory reform that would declassify broken monitors as hazardous materials. Reverse logistics problems also need to be addressed as well as work on effective plastics recycling to reduce costs and to meet new product quality requirements.

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IBM

As part of its Product End-of-Life Management (PELM) activities, IBM began offering product take-back programs in Europe in 1989 and continues to enhance and expand these offerings. There are currently 14 such programs in the U.S., Europe, and Asia. There are 9 major Materials Recovery Centers around the world, and additional locations support parts return and regional collection. In 1999 more than 59,000 metric tons of manufacturing scrap, IBM-owned end-of-life machines and customer-returned equipment were processed through these operations. IBM sent only 3.7% of this amount to landfills.

Recycling and dismantling expertise is shared among the Materials Recovery Centers in order to increase recycling efficiencies and reduce the amount of waste sent to landfills. In addition, the centers share their experiences, concerns and recommendations with IBM product development teams in order to ensure that issues affecting the end-of-life management of products are addressed early in the design phase of new products.

Pitney-Bowes (PB)

PB is a world leader in mail meters and mail systems as well as copiers and fax machines. Asset recovery has been an integral part of PB's operations for many years, in part because of U.S. Postal Service regulations that required postage meters to be leased and not owned. This means that PB must take-back leased metering equipment, making it easy for them to expand product take-back into other product lines. PB contracts out to third party vendors to do regional sweeps to pick up products and ship them to a cross dock until sufficient numbers have been accumulated and then parts are shipped to a regional PB disposition center.

A. Factors Encouraging Adoption of EPR

Cost saving was a primary driver in PB's adoption of product take-back and remanufacturing. Meter and mailing systems have a high residual book value, so recovery and subsequent remanufacturing is an efficient mechanism from an accounting standpoint.

B. Economic Assessment

PB estimates that total net savings from reused parts amounted to $8.2m in 1998. Remanufactured parts are offered to customers at one-half to one-fifth of the cost of a new part. These parts are especially beneficial when used to satisfy a PB service contract, where the difference between a remanufactured part and a new part is added to the profitability of the contract.

C. Assessment of Effectiveness

PB performs sophisticated tests such as signature analysis to ensure that remanufactured parts meet quality standards. The recovery process has led to improvements in product design and testing. Remanufactured products can benefit from design changes that might make them superior to new ones.

D. Barriers to Success
The costs associated with qualifying parts and components as reliable can be a barrier to the program's cost efficiency. Remanufactured systems compete with new systems in sales targets and can cannibalize sales. Customers' perceptions that remanufactured products are inferior to new ones can serve as an additional barrier, especially when customers' pricing requirements for these products are below PB's cost structure.

E. Future Improvements
PB is waiting for ISO standards that will govern the use of reused parts in new products.

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Xerox Corporation

Beginning in 1993, Xerox was undoubtedly the first U.S. corporation to begin an aggressive product take-back program. Xerox achieves this by leasing products to customers rather than selling them. This enables Xerox to recover the product through what it calls Asset Recycling Management (ARM). The returned products are sent to a dedicated recycling center to be remanufactured or disassembled for material reclamation.

A. Factors Encouraging Adoption of EPR
Xerox is committed to a strategy of environmental stewardship through the reduction of waste and promoting the use of recycled materials.

B. Economic Assessment:
The financial benefits of equipment remanufacture and parts reuse amount to several hundred million dollars a year.[25]

C. Assessment of Effectiveness
Xerox uses a design for the environment (DFE) strategy with the goal of producing waste-free products. Through the use of sophisticated signature testing, life-cycle analysis, design for analysis software and product coding Xerox has re-engineered its manufacturing process.

D. Barriers to Success
Misperception among some customers that products with some recycled part content are inferior to those built from all-new parts.

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HOME APPLIANCE (WHITE GOODS) INDUSTRY STRATEGIES

Prompted by landfill bans on white goods in 16 U.S. states, the appliance industry has committed itself to major structural changes in the way the industry designs, produces and distributes its products. An industry group known as MARMA, the Major Appliance Resource Management Alliance, has been organized to actively promote environmentally sound and sustainable management of material streams from the final disposition of major home appliances. Product refurbishment and remanufacturing as well as product leasing are other new developments in the industry.

Electrolux/Frigidaire Company[26]

Frigidaire has been a pioneer in designing products for recyclability. In 1994, it began a refrigerator recyclability assessment that instigated significant changes in product design. Plastic use was consolidated from three types into one resulting in cost savings from larger volume purchases from the remaining supplier. The number and complexity of parts in subassemblies was reduced which facilitated significant cost savings in material and labor inputs. Plastics were marked according to resin type to aid in identification and recycling.

Functional Sales: Pay-per-wash
In November 1999, Electrolux introduced a new pilot project called Pay-per-Wash, at the Gotland Island in Sweden. The island was chosen because it's the only place in the world thus far with Internet-connected electrical meters installed in 7 000 households, which allows for remote reading.

The customer borrows a new washing machine and pays only SEK 495, which is the actual cost for the installation. During the installation, the washer is connected via an "intelligent" electrical meter and the Internet to a central database that keeps track of consumption. The customer pays for the use of the washing machine, around SEK 10 per washing cycle, which is charged on the electricity bill. The machine is owned and serviced by Electrolux. When the machine has served its duty, it is taken back and can be scrapped, remanufactured or used as a source of spare parts.
Source: Electrolux website http://193.183.104.77/node338.asp?nodeurl=node95.asp

Endnotes

[1] *Oregon State of the Environment Report*, Oregon Progress Board, September, 2000.
[2] *Towards a Sustainable Washington*, Portland State University Center for Watershed and Community Health, December, 2000.
[3] The information for the French ELV program was adapted from the European Environmental Agency *Environmental Agreements-Environmental Effectiveness: Environmental Issues Series no. 3* from http://themes.eea.eu.int/showpage.php?pg=39282downloaded on 7/20/2000
[4] Dutch information in OECD, page 32. and the Swedish study is in *Fashions in the Treatment of Packaging Waste*, Multiscience Publishing Co. UK.
[5] From Bette Fishbein *Germany, Garbage and the Green Dot: Challenging the Throwaway Society*. INFORM, INC.1994
[6] OECD, page 28.
[7] *Strategies to Promote Clean Production Extended Producer Responsibility*. By Beverly Thorpe and Iza Kruszewska. http://www.svtc.org/cleancc/strat.htm downloaded 7/20/2000.
[8] Connecticut and the District of Columbia incinerate 65 and 70% of their municipal solid waste while Oregon burns 11% and Washington none. A fascinating look at America's garbage can be found in *Biocycle's "The State of Garbage in America."* Part one is in the April 2000 edition and part two in November 2000.
[9] Beverly Thorpe, *Background Document on Hazards and Waste from Computers*. Clean Production Action, 1999. Cited from the National Safety Council's Environmental Health Center, 1999. From http:www.most.org.pl/cpa/computer.html downloaded on 8/30/2000.
[10] Information on the Dutch recycling program was taken from Auto Recycling Nederland *Environmental Report 1999* from their website http://www.autorecycling.nl/eng/resultaten/f_resultaten_mil.html on 8/21/2000.
[11] See footnote #7.
[12] From Bette Fishbein *Germany, Garbage and the Green Dot: Challenging the Throwaway Society*. INFORM, Inc. 1994.
[13] From OECD publication # ENV/EPOC/PPC/(97)19REV2 p. 9.
[14] *Are Old PCs Poisoning Us?*, Business Week, June 12, 2000 pp. 78-80.
[15] Unless otherwise noted, the information for this section comes from *Waste Electronics* by the Regulatory Tracking and Interpretation Service, Sunnyvale, CA. http://www.eorm-rtis.com/sampden.htm
[16] Background information taken from "Industry Program to Collect and Recycle Nickel-Cadmium (Ni-Cd) Batteries" by Betty Fishbein in *Extended Product Responsibility: A New Principle for Product-Oriented Pollution Prevention* by Gary Davis and Catherine Wilt, June 1997.
[17] From the RBRC website www.RBRC.org
[18] EDN magazine, "Batteries clean up their act", February 4, 1999.
[19] Gary Davis, "Automotive Take-Back and Recycling Programs." *Extended Product Responsibility: A New Principle for Product-Oriented Pollution Prevention* by Gary Davis and Catherine Wilt, June 1997. Pages 5.9-5.12.
[20] Recycling information obtained from www.fujifilm.com/tcm.html
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[22] Kodak information comes from their website at www.kodak.com and from a personal conversation between Robert Fischmann, Kodak World wide Recycling Manager and Hal T. Nelson, Portland State University Center of Watershed and Community Health, September 11, 2000.
[23] The information in this section was obtained from a conversation between a Dell recycling manager and Hal T. Nelson, Portland State University Center of Watershed and Community Health, September 19, 2000.
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[26] Adapted from "The Frigidaire Company's Program for Recyclable Product Development of Refrigerators" by Catherine A. Wilt in *Extended Product Responsibility: A New Principle for Product-Oriented Pollution Prevention* by Gary Davis and Catherine Wilt, June 1997.