"Extended Producer Responsibilities" (EPR) Policies and Product Design Issues

Luminita Vochita Lecturer Ph.D., Laurentiu Dragomir Lecturer Ph.D.
University of Craiova, Faculty of Economics and Business Administration
luminitade@yahoo.com
dragomirlaur@yahoo.com

Abstract
Environmental policymakers have increasingly turned their attention to the environmental impacts of products. One concept—extended producer responsibility (EPR)—has captured the hearts of policymakers globally. Extended Producer Responsibility is a strategy designed to promote the integration of environmental costs associated with products throughout their life cycles into the market price of the products.
EPR policies generally impose a fee that is paid by manufacturers for targeted products, and establish specific take-back goals for each targeted material or product. If manufacturers pay for the post-consumer impacts of products, they will design them differently to reduce waste. But other opportunities to more fully include environmental values into product-design decisions exist, and their lack of realization should not be deemed market failure, but rather a natural consequence of the complexity of the design, production, and distribution of good and services, the physical impossibility of vigorously pursuing all values simultaneously, and the continual emergence of new values.
This paper focuses on the possibilities for the EPR principle to promote design change of products. A principal reason for allocating responsibility to producers is their capacity to make changes at source to reduce the environmental impacts of their product throughout its life cycle. It is essentially the producers that decide the features of the products they manufacture at the design phase of products. Rational manufacturers, when made responsible for end-of-life management of their products financially and physically, would presumably try to find a way to minimize the costs associated with end-of life management by changing the design of their products.
Most proponents of EPR assume that current product-design practices deter efficient resource use and don't adequately mitigate environmental impacts. Yet product-design trends belie this assertion. Manufacturers are moving toward reduced material-use per unit of output, reduced energy use in making and delivering each product, and improved product performance—including environmental performance.

Keywords: producer responsibility, consumer responsibility, design product, environmentally-related goals, EPR policy

1. Introduction

Since the term "extended producer responsibility" was first coined and the German packaging take-back law was passed in the early 1990s, the EPR concept has become an established principle of environmental policy in many countries. Although EPR means slightly different things to different people, a core characteristic of any EPR policy is that it places some responsibility for a product's end-of-life

environmental impacts on the original producer and seller of that product. The thinking behind this approach is that it will provide incentives for producers to make design changes to products that would reduce waste management costs. Those changes should include improving product recyclability and reusability, reducing material usage and downsizing products, and engaging in a host of other so called “design for environment” (DfE) activities.

Much that is written on this topic seems to take it on faith that any form of producer responsibility will provide DfE incentives, but there is very little careful conceptual thinking on how such incentives work through the system and sparse documentation of real-world changes that have been made in response to policies.

The policy instruments that lie under the EPR umbrella include different types of product fees and taxes commonly called “advance recycling fees” (ARFs), product take-back mandates, virgin material taxes, and combinations of these instruments. EPR instruments are contrasted with non-EPR policies such as “pay-as-you-throw” waste collection charges, landfill bans, and others. It is argued that a cost-effective instrument will be one that exploits all the possible avenues for waste reduction: source reduction, recycling, material substitution, and product design changes, and not just a single method. This means that policy options such as a combined ARF/recycling subsidy work better than an instrument that just targets, say, recycling. The take-back option is difficult to evaluate conceptually since much depends on how it is implemented in practice. All systems operate with “producer responsibility organizations” (PROs), and the financing mechanism that the PRO uses is a critical determinant of the option’s cost-effectiveness.

Some instruments that seem to more directly target DfE - take-back without a PRO, for example, and product fees and subsidies that vary by recyclability or some other product characteristic - are likely to be very difficult and costly to design, implement, and enforce. Their greater ability to spur DfE must be weighed against these added costs.

Several studies by economists have argued the merits of the combined ARF/recycling subsidy approach. A recent analysis that incorporates product design choices in the theoretical model confirms this policy option as an economically efficient one. When combined with a modest waste disposal fee, the ARF/recycling subsidy can achieve the socially optimal level of waste disposal, recycling, and product recyclability.

2. Background to Extended Producer Responsibility

2.1. Concept of EPR

Over the 15 or so years since the term “extended producer responsibility” was first coined in Sweden and the now famous German packaging “take-back” law was passed, the EPR concept has become an established principle of environmental policy in many countries. Although EPR means slightly different things to different people, a core characteristic of any EPR policy is that it places some responsibility for a product’s end-of-life environmental impacts on the original producer and seller of that product. In the *EPR Guidance Manual for Governments*, the OECD defines EPR as “an environmental policy approach in which a producer’s responsibility for a product is

extended to the post-consumer stage of a product's life cycle" (OECD, 2003).

The OECD goes on to say that in addition to the shifting of responsibility – either financial or physical - upstream to producers, it is also important that the policy "provide incentives to producers to incorporate environmental considerations in the design of their products" (OECD, 2003).

The emergence of the concept reflected several general trends in environmental policy-making. These trends are the prioritisation of *preventative measures* over end-of-pipe approaches, enhancement of *life cycle thinking* and a shift from the "command-and-control" approach to a non-prescriptive, goal-oriented approach. It aims to incorporate *incentive mechanisms* for industries to continuously improve their products and processes.

These three features relate to another fundamental element of the concept: *making producers the primary actor responsible for the entire life cycle of their products*. A principal reason for allocating responsibility to producers is their capacity to make changes *at source* to reduce the environmental impacts of their product throughout its life cycle. It is essentially the producers that decide the features of the products they manufacture at the design phase of the products. Assigning responsibility primarily to one actor would avoid the situation where everyone's responsibility becomes no one's responsibility. Moreover, in the policymaking and enforcement process it is practically easier to address producers who are relatively easy to identify than, for example, consumers.

So, with wider application of the concept, scholars and policy makers started to position EPR differently within the ladder of governmental policy-making. Rather than one of the policy instruments manifesting itself as a take-back scheme, deposit-refund system and the like, EPR is increasingly recognised as a policy principle underlying a range of preventative environmental policies.

In this paper, EPR is understood as: "a policy principle to promote total life cycle environmental improvements of product systems by extending the responsibilities of the manufacturer of the product to various parts of the product's life cycle, and especially to the take-back, recovery and final disposal of the product".

2.2. Types of Responsibilities

The extension of responsibilities to manufacturers varies between EPR programmes, both in terms of *types* of responsibility, and *activities* to be fulfilled within EPR-based policy instruments. Some authors categorised the types of responsibilities as liability, economic (financial) responsibility, physical responsibility, informative responsibility and ownership. The respective types of responsibility are described as follows:

Liability refers to a responsibility for proven environmental damages caused by the product in question. The extent of the liability is determined by law and may embrace different parts of the life-cycle of the product, including usage and final disposal.

Financial responsibility means that the producer will cover all or part of the costs for the collection, recycling or final disposal of the products he is manufacturing. These costs could be paid for directly by the producer or by a special fee.

Physical responsibility is used to characterise the systems where the manufacturer is involved in the actual physical management of the products or of the effects of the products.

The manufacturer may also retain the ownership of his products throughout their life cycle, and consequently also be linked to the environmental problems of the product.

Informative responsibility requires producers to supply information on the environmental properties of the products he is manufacturing".

2.3. Instruments for implementing EPR principle

2.3.1. Multiple policy instruments

There are several different policy instruments, and variants of those instruments, that fall under the EPR umbrella. Although they can be grouped in three main categories: administrative, economic and informative, they are numerous. The following is a list of the most common instruments; it is not meant to be exhaustive but includes most of the policy tools used in practice.

Product take-back mandate and recycling rate targets. With this policy approach, the government mandates that manufacturers and/or retailers take back products at the end of the products "useful lives". Combined with such mandates is some kind of recycling or waste diversion target. For example, the government may require that each producer meet a recycling rate goal for its products. The German packaging law works in this way: take-back is required and material-specific recycling rate targets are set. To meet these requirements, firms often form a "producer responsibility organization", or PRO, to handle collection, arrange for recycling, and ensure that recycling targets are met.

Product take-back mandate and recycling rate targets, with a tradable recycling credit scheme. This approach is the same as above but instead of each individual producer meeting the same target, tradable credits are issued and firms are allowed to trade among themselves. An industry-wide recycling rate target would be met, but some producers would do better than the target and others worse. There are several different ways that a tradable credit scheme could be set up and I discuss the possibilities more in the next section, but one example is the packaging system in the U.K. There, reprocessors of packaging materials issue so-called "packaging waste recovery notes", or PRNs, which firms and PROs can trade with one another to meet their recycling obligations.

Voluntary product take-back with recycling rate targets. In a purely voluntary approach, firms in an industry agree to organize a take-back system for their products and set recycling goals. There is no law or government regulation mandating compliance and no penalties for not meeting the goals. In the United States, there are a few instances of voluntary take-back programs of this type. The Rechargeable Battery Recycling Corporation (RBRC) represents manufacturers of rechargeable batteries who pay a fee to operate a collection and recycling system.

The Carpet America Recovery Effort (CARE) was created by an agreement among U.S. carpet manufacturers that arose out of a 2002 Memorandum of Understanding between those manufacturers and several state governments and the U.S. Environmental Protection Agency. The Memorandum set voluntary recycling rate goals for carpet to be reached by 2012.

Advance recycling fees. An ARF - which originally was referred to as an advance disposal fee, or ADF - is a tax assessed on product sales and often used to cover the cost of recycling. ARFs are often assessed per unit of the product sold but can also be assessed on a weight basis. ARFs may be visible to the consumer when he purchases a product - a separate line item on the bill, similar to sales tax - or they can be assessed upstream on producers and later be incorporated into the product retail price.

ARF combined with a recycling subsidy. An ARF raises money that can be used in a variety of ways. The incentive effects of the policy are highly dependent on both the type of ARF and what is done with the revenues. If a "back-end" recycling subsidy is used - either a subsidy per unit of the product recycled or per pound of material recycled - this leads to quite a different policy instrument than one in which the ARF revenues are used to cover the costs of managing waste or used to cover infrastructure costs, in a lump-sum fashion. California's used oil program, the western Canada used oil program, lead-acid battery programs in several U.S. states, and California's waste program are all ARF/recycling subsidy programs.

All of these policy instruments have the feature that they make the producer of a product financially or physically responsible for the end-of-life environmental impacts of the product he produces. In this sense, all could be considered EPR. However, they have very different incentive effects and ultimately may lead to different environmental outcomes. Also, costs of the instruments may differ widely.

There are other policy instruments that governments may employ that can leaded to similar outcomes to EPR but that do not focus upstream on producers. These non-EPR instruments are:

Landfill bans. Many U.S. states and several countries ban disposal of particular items in landfills (or incinerators). In the U.S., these bans cover white goods such as refrigerators, dishwashers, and the like, computer monitors, tires, various kinds of household hazardous wastes such as paints, fluorescent light bulbs, and batteries, and other items.

"Pay as you throw" pricing of waste collection/disposal. Over 4,000 communities in the United States charge a fee per container or per bag of trash collected at curb side. This is in contrast to not charging at all or charging a fee that does not vary with the volume of waste collected. In the Netherlands, the city of Oostzaan, as well as some others, charges a fee per kg of waste collected. In some countries, end-of-life fees are charged for specific items that are difficult to dispose of. None of these policies are aimed at the producer so do not qualify as EPR, but they may have some of the same effects on waste generation and recycling.

Recycling subsidies. Recycling subsidies in the context of ARFs was discussed above, but the government may raise funds from elsewhere and

subsidize recycling. The government could make a payment per unit or per kg of material recycled, or it could make lump-sum grants to communities or recycling centres. Such grants are quite common in the U.S. Whether the subsidy is per unit, per kg, or a one-time lump-sum payment will have different effects as we discuss in the next section.

Recycling investment tax credits. Recycling investment tax credits are also quite common. Here, the government gives a credit on income taxes to anyone who invests in recycling infrastructure, thus this is like a direct subsidy to capital.

2.3.2. The role of the EPR in policy instruments on waste prevention and management

Based on the aforementioned understanding of EPR, the responsibility of producers can be extended to various parts of the products' life. In practice, EPR programmes have to date extended the producer's responsibility to end-of-life management of products, which is often referred to as the "weakest link" for the producers in the product chain (Kroepelien, 2000). In this case, the extension of the manufacturer's responsibility means shifting part, or all, of the responsibility for end-of-life management of products from tax payers, waste management authorities and conventional waste dealers, to manufacturers. This shift may bring multiple, inter-related benefits for society, linking and affecting the various phases of the product's life cycle. With regard to waste management, an EPR programme helps to reduce the financial and physical burdens upon waste management authorities. They have often suffered from the inadequacy of existing waste management facilities and technologies for dealing with waste streams that are increasing both in terms of volume and variety. The elimination of toxic substances at source, or at least the separation of components using toxic substances from the rest of the waste stream can reduce the risk of health hazards and environmental damage caused by inappropriate waste management. Separation of toxic substances from the rest of the waste stream can also reduce the cost of waste management. Manufacturers' expertise and knowledge about their products can be communicated to waste managers (Lifset, 1993). The involvement of private actors tends to increase the efficiency of waste management practice, such as better logistics for transportation, especially when it is not subsidised. Some view the introduction of an EPR programme as a breakthrough that allows the privatisation of waste management, which had been monopolized by local governments (Tarasti, 1998; Jobin, 1997). Demand for separation and recycling created by the EPR programmes may also induce the development of separation/recycling technology.

If consumers realise that they pay for end-of-life management, they may become more sensitive to throwing away an old product. This may lead to a reduction in waste generation. It may also help create a wider demand and supply for second-hand products or longer-life products. Moreover, it is a way of charging the costs associated with end-of-life management of products to the beneficiaries of the products, instead of leaving the burden to tax payers. This leads to the implementation of the polluter pays principle on products outside production facilities.

The establishment of infrastructure for separate collection and the recovery of discarded products under EPR programmes would not only help improve waste management practice *per se*, but would also enhance possibilities for closing material loops. It also increases

opportunities for manufacturers to actually re-obtain the products and/or components for their own re-use and recycling. Sufficient and steady supply of high-quality recycled materials would help create demand for the recycled materials (Lee, 2002; Peck, 2003). Without such infrastructure, manufacturers' efforts towards design for re-usability and recyclability would be in vain.

Further, becoming responsible for the end-of-life management of their products financially and/or physically should force manufacturers to be more aware of the issues related to end-of-life management of their products. Rational manufacturers would presumably try to find a way to minimise the costs associated with end-of-life management by changing the design of their products (both in terms of structure and material use) (Peck, 2003). The establishment of this feedback loop from the downstream (end-of-life management) to the upstream (design of products) is the core of the EPR principle that distinguishes EPR from a mere take-back system (Lindhqvist, 2000). Just as with the establishment of infrastructure, the impact of the design change of products may not be limited to the prevention or reduction of environmental problems related to waste management. Improved design for end-of-life, coupled with infrastructure for separate collection and recovery, would facilitate closing part or all of the material loops. This would provide motivation to lift the value of materials that come to the downstream (Peck, 2003), thus contributing to the improvement of resource efficiency (productivity). A manifestation of the changes of the product system can be found in the shift from selling products to selling the function that a product can provide, referred to as a "product service system".

The aim of the environmental improvement mentioned above is the core reason why manufacturers of the final product (original equipment manufacturers: OEMs) are selected as the primary actor responsible. Among the actors in the product chain, it is manufacturers who are regarded as having the highest capacity to prevent problems at source by changing the design of their products/product systems. In almost all the existing EPR programmes importers are assigned the same responsibility as domestic manufacturers to cover both domestically-produced products and imported ones.

A well-designed EPR system focused on end-of-life issues creates incentives for design changes of products, influences the effectiveness of collection of discarded products, the extent to which collected products are treated in an environmentally-sound way, and secures a high use of products, components and materials in the form of re-use and recycling. Lindhqvist and van Rossem (2005) developed an evaluation tool for EPR programmes on behalf of Environment Canada and the Recycling Council of Ontario, which serves as a self-evaluation tool for identifying strengths and weaknesses of existing and planned programmes.

2.4. Principles for evaluating EPR instruments

2.4.1. *Feasibility*

Obviously, the administrative costs of designing, implementing, and enforcing compliance with a policy are key to whether an approach will be cost-effective in achieving its goals. Transaction costs incurred by participants in the marketplace in the course of complying with the policy are also important.

These cost concerns loom especially large in the debate about DfE. Some observers have criticized collective take-back systems and others have criticized approaches such as combined ARF/recycling subsidies, or deposit-refund schemes, because they do not seem to directly encourage DfE. However, alternative approaches that do seem more direct - individual take-back or fees and subsidies that vary with product recyclability - may have such high administrative and transaction costs that they are essentially infeasible. This is, of course, the reason that PROs were formed in the first place and why they continue to thrive in countries with take-back programs.

2.4.2. Multiple policy objectives

The goals of EPR, or any policy, need to be clearly laid out before policy instruments can be evaluated (Walls, 2004). And in all cases, we should strive to achieve the given environmental objective at the lowest possible cost to society. In the case of EPR, the environmental objective is often not clear. Some objectives that have been put forward are: 1.reduction in waste volumes generated, 2.reduction in waste disposed, 3.reduction in hazardous constituents in the waste stream, 4.decrease in virgin material use, 5.lowering of pollution in the production stage, and 6.increased DfE. Some observers have argued for achievement of all of these goals. The U.S. EPA describes product stewardship - the terminology more commonly used in the U.S. - as calling on “those in the product life cycle - manufacturers, retailers, users, and disposers - to share responsibility for reducing the environmental impacts of products”. The problem here is the broad range of “environmental impacts” of products and the lack of clarity in exactly what shared responsibility means.

A long-standing result in economics is that as many policy instruments are needed as policy goals. One instrument cannot efficiently accomplish all objectives. This means that if we want to reduce exposure to hazardous substances in products and also reduce volumes of waste generated from products, we are likely to need at least two instruments. For example, the European Union’s Restriction of the Use of Hazardous Substances Directive bans the use of lead, mercury, brominated flame retardants, and other hazardous substances in electrical and electronic equipment. We can compare this approach - an outright ban on the use of something - with alternative approaches to accomplishing the same end. But we cannot compare it to something like an ARF if the objective of the ARF is to reduce volumes of waste disposal. This is an apples to oranges comparison. Too often, EPR debates become mired in such discussions.

2.4.3. Individual versus collective take-back

Although the first generation of EPR programs involved collective take-back - PROs arranging with producers to collect and recycle their end-of-life products - there has been more interest of late in individual take-back programs. In such a situation, individual producers would be responsible for collecting and recycling their own products. Interest has arisen in this approach both because of the thinking that collective programs do not do enough to spur DfE and because some producers in some industries have advocated it. For example, U.S.-based computer equipment manufacturer Hewlett Packard has strongly argued that any state laws using an ARF approach allow for opt-out by individual companies that can demonstrate that they have their own take-back/recycling programs. The company’s arguments are based on the thinking that its own approaches will be more cost-effective than state-government sponsored systems. Similar thinking

was behind the collective arrangement of HP, Electrolux, Braun, and Sony to establish their own PRO to handle e-waste Europe-wide. Their express purpose was to provide competition to existing PROs in European countries while still achieving some scale economies in collection by uniting four companies' efforts.

There are obvious trade-offs involved in a collective system versus an individual one. While an individual system may provide more direct incentives for DfE, it may be difficult for the government to monitor and enforce the activities of many different individual companies. Moreover, there should be economies of scale in collection - many empirical studies of local waste and recyclables collection services have found that such economies exist (Walls et al., 2005) - thus many individual companies collecting their own products at end-of-life is sure to be excessively costly. On the other hand, mandating a PRO with joint collection and processing may be overly prescriptive; with the government choosing the system ex-ante, it eliminates the possibility for firms uncovering cost savings in collection and processing. Another potential disadvantage of a PRO is the possibility of anti-competitive behaviour. If one firm controls collection and contracts for processing of recyclables, it could lead to price gouging and other problems. Similarly, if firms in an industry cooperate to jointly arrange for collection and processing, forming a PRO on their own, there is the potential that they will collude on other things as well.

In general, if the government is going to impose take-back, it is best if it leaves options open for obligated firms to come up with innovative strategies on their own to manage that take-back since firms' incentives to minimize costs will help to reduce the overall costs of the system. Of course, a better option might be to bypass the take-back option for something even more flexible.

3. Requirements for EPR to lead to design change

3.1. Only new products can be redesigned

Allocating *individual financial responsibility* to producers for historical products – products that were put on the market before an EPR programme – is limited from the viewpoint of design change, as the design cannot be altered retroactively. In principle, historical products can be financed in any manner suitable for the respective society. However, the *physical involvement of the producers* would provide them with learning opportunities with regard to design for end-of-life. During a transition phase, a system based on individual responsibility requires consideration of the treatment of historical products. When it comes to the WEEE (Waste Electrical and Electronic Equipment) Directive, it stipulates that historical products must be financed by a fee based on products put on the market in the same period, that is, a fee on new products. Hence, the decision on how to finance historical products has already been made. As producers of new products are also obliged to finance their own future end-of-life costs, there will be a transition period when producers of all new products are paying into two systems. The Swedish system for end-of-life vehicles is a good illustration of how the two systems can be run in parallel.

3.2. Provision of incentives through differentiation

In terms of EPR programmes providing incentives to producers to design products for improved environmental performance from a life cycle perspective with a specific focus on end-of-life, the arguments are fairly straightforward – that is if a producer is financially responsible for his own products at end-of-life, then he/she will be rational and design products to minimise this cost. Of course, not all producers would consider this cost as a decisive factor influencing design (especially weighing all design factors). However, many have anticipated this cost to be significant and in the 1990s had already changed product design accordingly. When substance restrictions are considered as falling under the umbrella of EPR, design change implications are even more evident, especially in global market product groups such as electronics. It is crucial that to maintain this trend, EPR programmes are designed so that the efforts of these producers have at least the possibility of being acknowledged in terms of *differentiated end-of-life costs* when and where they are realised.

It is also essential that there are incentives to stimulate design changes not only of the products as such, but also of the whole product system. For instance, the end-of-life impact of a product depends on the collection system and the sorting, treatment and recycling systems. System changes, maybe leading to new business concepts, have potentially the largest opportunities for radical improvements. Also the treatment requirements should be formulated and implemented in a way that provides incentives for producers to strive for real environmental improvements.

3.3. Guarantee for future waste

It cannot be assumed that all manufacturers will be on the market and able to pay the costs when their products are discarded and treated. Some will have left the market and it will be impossible at this point to enforce a legal requirement for covering costs. A system based on individual producer responsibility necessitates a supplementary system to handle the “orphaned” products: products whose producers cease to operate in the market. To release producers remaining in the market from covering the cost for orphaned products, a guarantee is needed. This guarantee should be set up when the products are put on the market. A true financial guarantee is defined as: “each producer should, when placing products on the market, provide a financial guarantee to prevent costs for the management of orphan products targeted by EPR programmes from falling on society or the remaining producers”.

A ‘‘pay-as-you-go” system (PAYG) is the opposite of a system with true guarantees. Under the pay-as-you go system, when products are put on the market, the producer pays not for the products’ future end-of-life costs, but the products that have been collected in the same year. This does not lead to a reward for design change and hence does not drive development of better products.

3.4. Choice of end-of-life management and treatment options

Most businesses outsource a substantial part of their activities and use suppliers to provide them with various materials, components and services. This holds true for end-of-life management. Given that producers are presumably rational economic actors, it is unlikely that

they will directly provide the capital to finance new collection or recycling infrastructure, if existing economic actors, which could be contracted for this service, are available on the market. A producer assuming individual producer responsibility must be able to do the same as long as the fundamental requirements of the EPR system are fulfilled. An essential condition for a viable design-change-promoting EPR system is that it provides room for various solutions to be adopted.

One option for a producer is to buy some services from what it is called a “collectively-organised compliance system”. However, in these cases it is important that participation in the collective system makes the producer fulfil the same obligation as any other solution. Only with this last requirement will we create conditions for real competition between solutions and thus innovation on product design and design of systems for collecting and treating discarded products.

All these lead to the conclusion that the dualistic nature of collectively-versus-individual responsibility in the debate is often falsely positioned. It is clear that it is, and has been, possible to implement individual producer responsibility within collectively-organised industry-run compliance schemes for a variety of EEE (Electrical and Electronic Equipment) product groups. Therefore this phenomenon may be better described as a continuum of different individual and collective approaches. It is possible to have both completely collective and completely brand-specific or limited brand systems for compliance at the extremes of the continuum, and hybrid type systems which are designed to include the strengths of both systems (collectively-organised compliance systems with individual financial responsibility), all operating simultaneously.

3.5. Level playing-field and flexibility

An overarching condition for enabling EPR that promotes design change to be implemented is the provision of a level playing-field. Competition is a fundamental prerequisite for efficiency. It means that it must be possible for new actors to enter the market and to compete on equal terms. A well-designed system will ensure that no unnecessary barriers hinder such entrances. This means that it must be possible for alternative collection, treatment and recycling systems to be established. It also means that it must be possible for producers to select the way they want to exercise their producer responsibilities: by establishing own systems and partly or fully using the services of other organisations, provided they guarantee the required occupational health and safety and environmental standards.

For economic efficiency, it is essential that a producer can leave a system and join a new system or establish his own system. This will force the various actors to improve their systems continuously. This is equally important when it comes to the system of financial guarantees. A producer must be able to shift the way of organising the financial guarantee without jeopardizing the guarantee for the products that have already been put on the market and without jeopardizing the guarantees of an organisation he/she belonged to earlier. To have a level playing-field and a system with competition to secure efficiency, it is necessary that all accepted ways of fulfilling producer responsibility face the same requirements to fully cover the costs of the end-of-life phase and provide a guarantee for these costs that allows a dynamic development on the market.

4. A study case regarding Directive 2002/95/EC RoHS – severely impacting product design

Directive 2002/95/EC on restricting the use of certain hazardous substances in electrical and electronic equipment (RoHS) was originally included in provisions of the WEEE Directive. It was subsequently moved to become a separate Directive falling under Article 95 of the EC Treaty, whose legal basis is the functioning of the single market, which means that EU Member States cannot go further than the requirements in the RoHS Directive, like banning further hazardous substances. In addition to the harmonisation of substance restrictions across Member States, the Directive also aims to "contribute to the protection of human health and the environmentally-sound recovery and disposal" of WEEE (Art. 1). The Directive bans the use of cadmium (Cd), mercury (Hg), lead (Pb), hexavalent chromium (chromium VI) and two brominated flame-retardants: polybrominated diphenylethers (PBDEs) and polybrominated biphenyls (PBBs) by 2006, with exceptions in some applications. These substances are to be banned from EEE products because of the associated impacts when improperly disposed of in incinerators or landfills. According to the European Commission, even though the WEEE Directive mandates the separate collection of EEE products, the "soft" recovery rate of 4 kg/person/year will still allow for significant disposal of ICT, and therefore the banning of these substances is required.

Several electronics industry observers have estimated that the WEEE and RoHS Directives will have a wider impact on the sector than the Y2K bug, which similarly mobilised the industry on a global level to meet encroaching deadlines. This is characterised by numerous statements made by industry analysts or company representatives.

Other evidence confirming the global shift to lead-free electronics can be found by taking a closer look at the number of component manufacturer discontinued parts over time. Discontinued, or end-of-life (EOL) parts, are components that are no longer produced or supplied by manufacturers to the market. For example, in 2000 there were a total of 90,000 EOL announcements, while in 2004 this figured was estimated up to 150,000 (Jorgensen, 2005).

Original Equipment Manufacturers (OEM) must choose whether to purchase remaining stock, ask distributors/suppliers to purchase on their behalf, or redesign that part out of the product. Either way the manufacturer bears the cost of redesign or having shortages or surpluses of certain components. Given that passive and semi-conducting components are highly commoditised, it is not surprising that when one market segment (Europe) bans the use of certain hazardous materials in components, the feasibility of having multiple product-lines is questionable. With recent RoHS-like law in China and California, the argument for a global switch to lead-free and other hazardous materials reductions is only reinforced. This global phase-out strategy has been confirmed by some of the world's largest producers of IT equipment, including HP, Sony, Dell, Toshiba, Samsung, with many Japanese manufacturers superseding the RoHS 1 July 2006 deadline by several years. Green procurement requirements set by Sony, Hitachi, NEC, Toshiba, and other Japanese companies caused global suppliers to remove hazardous substances years before RoHS took effect in July 2006. Japanese electronics manufacturers had been moving forward with these developments in an attempt to increase European

market share in advance of the compliance deadline (Murphy & Pitts, 2001). Although this has positive implications for ensuring that manufacturers meet the July 2006 deadline for the phase-out of lead, this trend may have negative implications when discussing reuse opportunities for products put on the market before July 2006. Despite the exemption of spare parts for repair and re-use of EEE put on the market before 1 July 2006, the requirements in RoHS may accelerate the reduction of available spare parts. However, on a positive note, it may also increase demand for removal of these components from end-of-life products collected from B2B customers or municipal collection sites.

5. Conclusions

1. EPR programs have proven themselves in terms of reducing waste associated with consumer products and increasing recycling rates; in all countries with such programs, documented increases in recycling have occurred.

2. It also appears that a limited form of DfE has taken place in many instances - reductions in material use and product/packaging downsizing - in response to policy.

3. There are several different means by which these accomplishments can be, and have been, achieved; traditional product take-back mandates combined with recycling rate standards are one way and in virtually all of these programs, collective implementation with a PRO is the rule, but combined ARFs/recycling subsidies lead to the same outcomes and may be more cost-effective.

4. It is too early to say whether more complex forms of DfE for highly designed and engineered products such as electronics and motor vehicles can be encouraged with EPR policy, but it seems unlikely that large changes will result from the types of policies we currently see in place; in particular, PROs, as they currently operate, provide very little incentive for members to engage in DfE.

5. Policies that directly target DfE - individual firm take-back programs and/or fees and subsidies that vary with product characteristics - are likely to be very costly and difficult to implement and enforce; nonetheless, research into, and experimentation with, such policies may be useful.

6. Policy-makers need to keep in mind that multiple policy instruments are necessary for efficiently accomplishing multiple environmental goals; thus, one instrument cannot, for example, efficiently reduce the hazardous constituents of products and also reduce waste volumes, and comparisons between such instruments should not be made.

7. As more experience is gained with electronics and vehicle programs, more data and information should be systematically collected from all participants so that the programs can be better evaluated. This information should include data on material use, both types and volumes, product weight, information on ease of dismantling, labeling information, and more. It will always be difficult to attribute observed changes to policy, but a first step is to collect better data.

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