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Producer responsibility for e-waste management: Key issues for consideration – Learning from the Swiss experience

Deepali Sinha Khetriwal [a,*], Philipp Kraeuchi [b], Rolf Widmer [b]

[a] Technology and Society Lab, EMPA (Swiss Federal Laboratories for Materials Testing and Research), 11 St. Peter's Court, London NW4 2HG, UK
[b] Technology and Society Lab, EMPA, (Swiss Federal Laboratories for Materials Testing and Research), Lerchenfeldstr. 5, CH-9014 St. Gallen, Switzerland

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Abstract

E-waste, a relatively recent addition to the waste stream in the form of discarded electronic and electric equipment, is getting increasing attention from policy makers as the quantity being generated is rising rapidly. One of the most promising policy options to address this issue is to extend the producers responsibility for their products beyond the point of sale, until end-of-product-life. This paper briefly introduces the concept of extended producer responsibility (EPR) and its applicability in the area of the end-of-life management of electronic and electrical equipment (EEE). It then examines the decade-long experience of Switzerland in using EPR to manage its e-waste, elaborating on the experience of the Swiss system in overcoming specific issues, and finally wrapping up with a synopsis of the lessons for policy makers. We consider each issue as an enquiry of questions confronting a policy maker and the choices that may present themselves. The five issues discussed are: (i) the challenges in getting an EPR based system started; (ii) securing financing to ensure a self-sustaining and smooth functioning system; (iii) organising a logistics network for the take back and collection of the e-waste; (iv) ensuring compliance of the various actors involved; and finally (v) reducing the threat of monopolistic practices.

Keywords: e-Waste; WEEE; Extended producer responsibility; EPR; Environmental policy

1. Introduction

The use of electronic and electric equipment has grown exponentially over the two decades, especially as a result of the information and communications technology revolution. The introduction of newer gadgets coupled with rapidly falling prices has also meant quicker obsolescence. Consequently, the volume of waste electric and electronic equipment (WEEE) is growing rapidly, and is believed to be one of the fastest growing waste streams in Europe. Not surprisingly, e-waste or WEEE, a relatively recent addition to the waste stream, is getting increasing attention from policy makers.

Despite the fact that the Basel Convention, a global treaty to control and reduce transboundary movements of hazardous waste, under which WEEE is also covered, has been in force since 1992, there has been little by way of national legislation for managing WEEE directly. Europe is so far leading the way in framing and implementing policies to manage its WEEE stream. While the European Union's WEEE Directive came into force in January 2003, a few countries already had WEEE specific systems and legislation in place before (more details in Table 1).

WEEE is a very different kind of waste as compared to traditional municipal wastes. Conventional waste management policies more suited to handle traditional waste types cannot be applied in the case of the e-waste stream due to it characteristic of containing both highly toxic substances which pose a danger to health and environment, as well as valuable raw materials which can be recovered. In fact, a study by Huisman (2003) on e-waste recycling found that many base metals can be recovered to over 90%, while precious metals can be recovered to an extent of 97%-98%. Hischier et al. (2005) studied

* Corresponding author.
E-mail addresses: sinha.deepali@gmail.com (D.S. Khetriwal), philipp.kraeuchi@empa.ch (P. Kraeuchi), rolf.widmer@empa.ch (R. Widmer).

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Table 1
WEEE legislation in Europe

Country	Legislation	Responsibility	In force since
Switzerland	Ordinance on the Return, Taking back and Disposal of Electrical and Electronic Equipment. (ORDEE)	Manufacturer/importer	July 1998
Denmark	Statutory Order from the Ministry of Environment and Energy No. 1067	Local Govt.	December 1999
Netherlands	Disposal of White and Brown Goods Decree	Manufacturer/importer	January 1999
Norway	Regulations regarding Scrapped Electrical and Electronic Products	Manufacturer/importer	July 1999
Belgium	Environmental Policy Agreements on the take back obligation for waste from electrical and electronic equipment	Manufacturer/importer	March 2001
Japan	Specified Home Appliances Recycling Law (SHAR)	Manufacturer/importer	April 2001
Sweden	The Producer Responsibility for Electrical and Electronic Products Ordinance (SFS 2000:208).	Manufacturer/importer	July 2001
Germany	Act Governing the Sale, Return and Environmentally Sound Disposal of Electrical and Electronic Equipment (ElektroG Act)	Manufacturer/importer	March 2005

the complete Swiss WEEE recycling and disposal activities including the processing of all resulting fractions and compared the environmental impacts of recycling to the impact of avoided primary production of the various raw materials. They found the environmental impact of recycling WEEE negligible as compared to the impact of primary production, indicating that WEEE recycling is in fact an environmentally preferable option.

However, what makes WEEE management a difficult task is the lack of previous studies, which directly address policy makers' concerns. A few pioneering studies are the Carnegie Mellon study published by Matthews et al. (1997) on estimating e-waste; a Mclaren et al. (1999) study on a pilot cell phone take back scheme in the UK; and Jung and Bartel (1999) study analysing the feasibility of taking back and recycling computers in San Jose, California.

Tojo (1999) does an in-depth study of the Japanese regulation for household appliances, also comparing the Japanese law with several European counterparts. Lindhqvist (2000) also touches upon the subject of WEEE management, but only briefly in the context of extended producer responsibility.

In this paper, we propose and discuss, considering as an example of the Swiss case, five key questions regarding financing, compliance and operational organisation that policy makers would need to address when embarking on an EPR based WEEE management system.

- How to get an EPR based system started?
- How to ensure a financially sustainable system?
- What should the scope and logistics arrangement of the system be?
- How does the system ensure compliance of the various actors?
- How does the system prevent the abuse of monopoly powers?

In-depth semi-structured interviews with Swiss government administrators and experts from the EEE manufacturing industry as well as producer responsibility organisations were used as the basis for the research.

We begin with a brief overview about what e-waste and extended producer responsibility (EPR) is, followed by Section 2, which provides an outline of the EPR based Swiss e-waste management system, its material and financial flows. Section 3 provides insights into how the Swiss system evolved and an in-depth discussion on the challenges faced, the solutions developed and the lessons that can be learnt. Section 4 concludes the paper with suggestions for further reference on EPR based systems as well as directions for future research.

1.1. What is e-waste?

e-Waste is often misunderstood as comprising only computers and related IT equipment, or worse still, mistaken for email spam. Widmer et al. (2005) have presented several prevalent definitions and use the term e-waste and WEEE synonymously. According to the OECD, e-waste is ''any appliance using an electric power supply that has reached its end-of-life''. Sinha et al. (2005) define it as 'any electrically powered appliance that no longer satisfies the current owner for its original purpose'. Thus, e-waste includes both 'white' goods (e.g. refrigerators, washing machines, microwaves) and 'brown' goods (e.g. televisions, radios, computers) that have reached their end-of-life for their current owner.

In this paper as well, WEEE and e-waste are used as synonyms, and include all the 10 categories (refer Table 2) as specified in the EU WEEE directive (EU Directive 2002/96/EC), which has become the most widely accepted classification.

1.2. What is EPR?

Extended Producer Responsibility (EPR) is defined as *an environmental protection strategy that makes the manufacturer of the product responsible for the entire life cycle of the product and especially for the take back, recycling and final disposal of the product* (Lindhqvist, 2000). Thus, *the producer's responsibility for a product is extended to the post consumer stage of a product's life cycle* (OECD, 2001).

Sometimes known as manufacturer take back or product stewardship (Lifset, 1993), the EPR movement began in Europe. The original impetus for it was two-fold: to relieve municipalities of some of the financial burden of waste management, and to provide incentives to producers to reduce resources, use more secondary materials, and undertake product

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Table 2
EU Classification of WEEE

WEEE Category	
1	Large Household Appliances
2	Small Household Appliances
3	IT and telecommunications equipment
4	Consumer equipment
5	Lighting equipment
6	Electrical and electronic tools
7	Toys, leisure and sports equipment
8	Medical devices
9	Monitoring and control instruments
10	Automatic dispensers

design changes to reduce waste (OECD, 2001). Over 25 nations have some form of EPR program. EPR is most commonly applied for packaging waste, the most famous being Germany's packaging ordinance. However, batteries, electronic and electrical appliances and automobiles are also increasingly coming under EPR programs.

The four principal goals of EPR, according to the OECD, are:

(i) Source reduction (natural resource conservation/materials conservation).
(ii) Waste prevention.
(iii) Design of more environmentally compatible products.
(iv) Closure of material loops to promote sustainable development.

EPR can be implemented through administrative, economics and informative instruments. The manner in which the concept of EPR is incorporated and implemented can differ from one programe to the other. A few approaches to implementing EPR policies are given in Table 3.

1.3. EPR and e-waste

The emergence and evolution of the concept of EPR reflects several trends in environmental policy making, which include, inter alia; a shift from so-called end-of-pipe approaches to preventative environmental strategies; life cycle approach; and wider use of non-prescriptive policy instruments (Tojo, 1999). Walls (2003) argues that EPR policies are preferred over non-EPR policies in cases when either there is a problem of illegal disposal of the waste stream or as a remedy to poorly functioning recycling markets. Electronic and electrical products are a major focus of EPR policies around the world (Fishbein, 1998), and especially in Europe, where over the last couple of years, several countries have favoured an EPR based e-waste policy.

As Table 1 shows, the majority of the governments have opted to make producers responsible for the taking back and final disposal of their equipment.

It should be noted that the manner in which each nation/region incorporates EPR into its legislation, as well as the actual implementation measures, differs. The differences manifest themselves in, among other things, scope (e.g. all EEE vs. large home appliances), range and type of producer responsibility (e.g. collective responsibility vs. individual responsibility), and funding mechanism (i.e. who pays how much, at which points?). The European Union is an example in the diversity in the implementation of EPR. The WEEE Directive, though common for all member states, has not only been transposed into national laws differently by each member, its implementation differs even within each member state, where different models of compliance can compete with each other.

2. E-waste in Switzerland

Switzerland is a high-end, mature consumer market for electronic and electrical products. In terms of per capita ICT, it has consistently ranked on top, spending US$ 3618 per capita in 2001, (WITSA, 2002). Even though the market penetration of or EEE in Switzerland is high, the demand for new EEE remains strong. The manufacture of EEE in Switzerland is negligible as compared to the volume of goods consumed. Manufacturers and traders import the majority of the EEE sold in Switzerland, thus producer responsibility embraces all those manufacturing, assembling and importing EEE. e-Waste in Switzerland was approximately 2.6% of the total municipal solid waste stream in 2003 (SAEFLa, 2004).

Table 3
EPR Approaches source: Extended Producer Responsibility: a Guidance manual for governments (OECD, 2001)

Type of EPR approach	Types of tools	Examples of EPR applied
Product take back programs	Mandatory take back	Packaging (Germany)
	Voluntary or negotiated take back programs	Packaging (Netherlands, Norway)
Regulatory approaches	Minimum product standards	EEE, Batteries
	Prohibitions of certain hazardous materials or products.	Cadmium in Batteries (Sweden)
	Disposal bans	EEE in landfills (Switzerland)
	Mandated recycling	Packaging (Germany, Sweden, Austria)
Voluntary industry practices	Voluntary codes of practice	Transport packaging (Denmark)
	Public/private paservicizingrtnerships	
	Leasing, "servicizing", labelling	Photocopiers, vehicles
Economic instruments	Deposit-refund schemes	Beverage packaging (Korea, Canada)
	Advance recycling fees	EEE (Switzerland, Sweden)
	Fees on disposal	EEE (Japan)
	Material taxes/Subsidies	

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Switzerland has been a pioneer in legislating e-waste management. Legally, e-waste management was introduced in 1998 by the Swiss Federal Office for the Environment (FOEN), by way of the Ordinance on 'The Return, the Taking Back and the Disposal of Electrical and Electronic Equipment (ORDEE)". However, the formal collection and management of WEEE started before the legislation came into force, driven by voluntary initiatives of producer responsibility organisations (PROs).

A producer responsibility organisation (PRO) is a cooperative industry effort to shoulder the responsibilities of its member companies and meet their EPR obligations. The PROs bear the operational responsibility of ensuring the proper management of e-waste, by managing the financing, collection, transportation and control systems. Currently, in 2007, in Switzerland there are four PROs, all of which are not-for-profit organisations, and between them manage the entire gamut of electronic and electrical products from household goods to office and consumer electronics to toys and leisure products as well as lighting equipment and consumer batteries. SWICO Recycling Guarantee and SENS (Swiss Foundation for Waste Management) are the two largest PROs. They manage the WEEE streams of grey, brown and white goods, including categories 1–5, 6 and 7 of the EU Classification of WEEE (refer Table 2). The other two, SLRS (Swiss Light Recycling Foundation) and INOBAT (Stakeholder Organisation for Battery Disposal), are much smaller, and handle only lighting equipment and consumer batteries, respectively.

In this paper, we focus only on two PROs – SWICO and SENS – which handle the largest part of the e-waste stream in terms of weight and volume and also have a significant operational history, which provides an insight into the evolution of the entire system.

Both SWICO and SENS had established a collection, disposal and financing system well before the legislation made it mandatory for all producers of EEE to bear responsibility for the end-of-life disposal of their products. They started, and still remain, as voluntary membership organisations, with committees of producer representatives to take decisions on important matters such as setting the Advance Recycling Fee (ARF) and scrutinising bids for recycling contracts. The close interaction between FOEN and the PROs at the early stages of the system and during the legislative process resulted in greatly reducing the burden of federal authorities in establishing an e-waste management system using a top-down approach. The industry welcomed the legislation, as it helped provide a legal framework to the respective actors involved in collection and recycling activities, and create a level playing field (Tojo, 2003). The general consensus from government and industry officials is that the current system though can be improved on minor aspects, works efficiently and equitably and economically.

2.1. The Swiss e-waste management system

The ORDEE forms the legal basis of the Swiss e-waste management system. Section 2 of the ORDEE deals with the return, taking back and disposal of WEEE. It outlines the obligation of users for the proper return of WEEE (Art. 3) and the obligation of traders and manufacturers to take back (Art .4). Disposal of WEEE is dealt with in articles 5–8, relating to obligations and requirements of disposal as well as the conditions required to obtain a disposal permit. Switzerland is a signatory of the Basel Ban on transboundary movement of hazardous wastes, and Section 3 lays out the stringent conditions that need to be met before WEEE can be permitted for disposal abroad.

The essential element of the Swiss e-waste management system is that it is an EPR based system with a clear definition of roles and responsibilities of all stakeholders involved. The stakeholders and their responsibilities are shown in Table 4. Some are mandated by the ORDEE while the others (shown in italics) have been stipulated by the PROs.

2.2. Material and financial flows in the Swiss e-waste management system

2.2.1. Material flow

As shown in Fig. 1, the circular flow of materials aims to optimise a closed loop material cycle, with the raw materials

Table 4
Actors and responsibilities in the Swiss e-waste management system

Actor	Roles and responsibilities
Government	The federal government plays the role of an overseer, framing the basic guidelines and legislation. Cantonal authorities play a part in the overall control and monitoring in their capacity as the licensing authority for recyclers.
Manufacturers/Importers PROs (SWICO, SENS)	Importers carry the economic and physical responsibilities of their products. *Have the role of managing the day-to-day operations of the system, including setting the recycling fees, as well as licensing and auditing recyclers.*
Distributors & retailers	Bear a part of the physical and informational responsibility of the product. Are obligated to take back products in categories they have on sale, irrespective of whether the product was sold by them, or whether the consumer purchases a similar product as replacement. *Are responsible for clearly mentioning the amount of the ARF in the customer invoice.*
Consumers	Are responsible, and obligated by law, to return discarded appliances to retailers or designated collection points. *Bear the final financial responsibility through the recycling fee on new product purchases.*
Collection points (specifically designated locations)	*Collect all kinds of WEEE free of charge and ensure the safety of the disposed products to prevent pilferage or illegal exports.*
Recyclers	Must adhere to minimum standards on emissions and take adequate safety measures concerning employee health. Need authorisation to operate a recycling facility from the cantonal government, *as well as a license from the PROs.*

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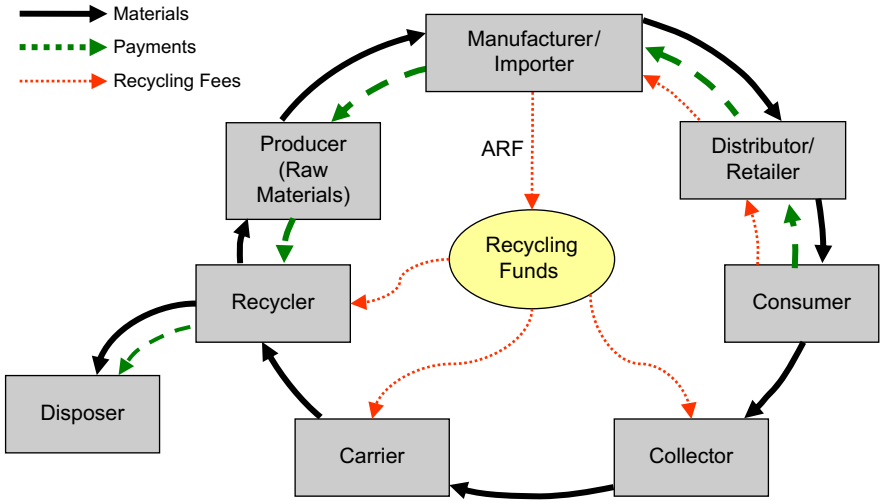

Fig. 1. Flow of materials and finances in the Swiss e-waste management system.

converted to finished EEE going through the retail and consumption stages and then at the end-of-life being collected and recycled to be put back into the production of new goods. Consumers small and large return WEEE through the channel most convenient to them – either through designated collection points, retail outlets, or transporting directly to the recyclers. From the collection points, the material is transported to dismantling facilities, which are often integrated with social institutions, to pre-sort the pallets of mixed appliances, manually dismantle them and most importantly decontaminate the e-waste by extracting the most toxic components in a safe and protected manner. At the recyclers, the e-waste goes through further dismantling, shredding and sorting, resulting in concentrates of mainly plastic, glass, iron, aluminium and copper which also contains most of the precious metals. Most of this recyclate is then sent to a refiner or smelter for final material recovery. The rest, from which raw materials cannot be recovered, goes to the incinerator for energy recovery and a small portion, currently less than 2%, goes to the landfill (SAEFLb, 2004).

2.2.2. *Financial flow*

The producers pay the ARF to the PROs (e.g. SWICO or SENS) on the sale or import of an appliance. This ARF is passed down to the distributors and retailers who in turn invoice the consumers on the purchase of a new appliance. The ARF is used to pay for the entire system for collection, transport, dismantling, decontamination and recycling of the disposed appliances. While retail stores are required by law to take back old appliances, and are not compensated for this activity, collection points, such as railway stations, are paid for the waste collected on a per kg or per piece basis, depending on the type of waste. The e-waste is transported from the collection points to the dismantling or recycling facilities by authorised transporters who are paid a fixed transportation fee per kg or per piece depending on the type of e-waste. The largest part of the ARF goes to the recyclers for the dismantling, decontamination, sorting, shredding and segregating operations, necessitated by the large variety of materials including metals, plastics, glass, rubber etc. and are stipulated in the recycler's contract with the PRO. Thus, the difference between the recoverable value and the overall processing costs is met by the ARF.

Table 5 shows the material and financial flows for both SWICO and SENS and the system as a whole.

3. Key issues for consideration

The Swiss experience of managing e-waste using the relatively new concept of EPR as opposed to traditional waste

Table 5
SWICO and SENS material and financial flows for 2004

	SWICO	SENS	System total
	2004	2004	2004
Material flow (in metric tonnes)			
Collection at retail outlets	15,292	10,493	25,785
Collection at collection point	7646	23,040	30,686
Collection by recycling service	9102	2842	11,944
Other	4369	0	4369
Total quantity collected (metric tonnes)	36,409	36,375	72,784
Financial flow (in million CHF)			
Total ARF income	40.67	43.70	84.37
Recycling expense	27.28	18.62	45.90
Transport & logistics expense	7.61	7.85	15.46
Collection point expense	2.22	4.12	6.34
Recycling of packaging materials/batteries	2.85	0.13	2.98
Other (PR, Controlling, Administration etc.)	1.58	1.91	3.49
Total expenses (million CHF)	41.54	32.64[a]	74.18

Source: SWICO and SENS.
[a] Difference in summation due to rounding errors.

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management strategies can provide several insights to policy makers and electrical and electronic goods manufacturers alike. In this section we explore five key issues, which we think are vital in any discussion on applying EPR as a policy for e-waste management. We consider each issue as an enquiry of how or what confronts a policy maker and the choices that may present themselves. And then we elaborate the experience of the Swiss system in answering these questions.

1. Getting the system started: how to overcome inertia?
2. Securing financing: how to ensure that the system is financially sustainable?
3. Getting the collection logistics right: what should the scope and logistics arrangement of a system be?
4. Ensuring compliance: how to ensure all actors fulfil their responsibilities?
5. Restricting monopoly: how to prevent anti-competitive practices?

These issues, while by no means the only issues that a policymaker needs to consider, should provide some guidance in evaluating EPR policy alternatives. We believe that these five issues encapsulate the most relevant questions and provide a broad framework upon which further discussions can be based.

3.1. Getting the system started: how to overcome the inertia?

Policy makers and producers, both grapple with the dilemma over who should take the first step. Should the policy first be in place before producers will be forced to follow? Or should the producers pre-empt policy, especially in the context of EPR, because policy deliberations are lengthy? With the benefit of hindsight, we look at how this inertia was overcome in Switzerland.

The first instance of WEEE management in Switzerland was the formation of SENS in 1990 as a note for profit organisation to ensure the proper disposal of refrigerators and freezers. Around the same time, in 1991, the first EPR legislation was also coming into force – the German Packaging Ordinance – making producers responsible for the take back and recycling of their products' packaging. The IT producers (including original equipment manufacturers as well as importers) realised that it would be only a matter of time before such legislation would be introduced for their products as well. In addition, large institutional clients of IT manufacturers, with multiple vendors for similar equipment, wanted a convenient and transparent system to dispose their obsolete equipment.

A few producers took the initiative to develop a collective e-waste management system, in spite of reservations from other producers, both within and outside the IT industry. SWICO, as the association of the manufacturers/importers, was approached, to establish such a system that would benefit all its producer members. As a result, the SWICO Recycling Guarantee started in 1994, as a financially independent not-for-profit organisation under the SWICO association. It began with a small loan from the association to finance the initial year of operations, and only 32 companies, including major IT and office electronics manufacturers like Apple, IBM, Canon and Compaq (SWICO, 2004) as participants. In a decade, this membership has grown to encompass 329 participants (SWICO, 2004). SENS too has expanded its mandate from only refrigerators and freezers to include all household appliances (normally categorised as 'white goods') and has 250 partners, covering 98% of the household appliances manufacturers (SENS, 2004).

The benefit of having a working system in place before legislation was introduced meant that the producers had the chance to develop a system, which was both flexible and not as expensive. The Swiss experience shows that producers need not have to wait for the government to force them to take responsibility for the end-of-life disposal of their products. Additionally, to get the system started, it is not practical to wait until all the producers are on-board. The critical mass is reached by a small group of large producers, mainly large multinationals, which dominate the market for EEE. A pertinent question is whether this can be achieved in other countries as well? Given the global footprint of the EEE industry, and specially as it is dominated by large multinational corporations, it would be possible to easily transfer operational and system knowledge gained from setting up such voluntary systems in Switzerland and apply them in other geographies. Switzerland is also not alone in the development of voluntary PROs, and there are similar instances in Sweden, Belgium, Norway and Netherlands where EEE producers have established take back system in advance of government or the WEEE regulations. The threat of increased regulation and compliance burdens of a government designed take back system which can be more expensive to implement is also a persuasive argument for producers to set up voluntary initiatives.

3.2. Securing financing: how to ensure a financially sustainable system?

One of the reasons why EPR is becoming popular as a policy measure to manage complex waste streams is because it does not place any financial burden on the local government. However, there are costs involved in the collection, transportation, sorting, dismantling and environmentally safe recycling of the waste. In case the intrinsic recoverable value is not enough to meet these processing costs, additional funding, such as a recycling fee, is required. In case additional funds are required, the questions that immediately arise are who should pay, how much, and at which point so that the system is financially stable and can meet its operating expenses. We look at how some of these questions are answered in Switzerland.

3.2.1. Setting the recycling fee

The recycling fee is levied to cover the gap between the total system cost and the total recovered value from the e-waste.

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In the Swiss EPR based e-waste management system, the end consumer bears the final financial responsibility of this recycling fee. The recycling fee is a function of sales of EEE and the costs for the collection and recycling of the e-waste generated. SWICO and SENS show two feasible options of setting such a recycling fee.

The recycling fee is set by the SWICO Environmental Commission, which comprises of producers from the various industry verticals participating in the system, and is revised annually. SWICO uses a product price index according to which the recycling fee is calculated. In 2005, the fee ranged from zero, for products below CHF 50, to CHF 1500 for products above CHF 600'001. For consumer electronics, the fee is structured slightly differently, depending on product category.

SENS on the other hand has six distinct fee categories, ranging from CHF 1 to CHF 40, under which all the products are classified. The category under which a product falls depends on the type as well as size of the product. For example, the recycling fee on a hair dryer is CHF 1 while on a refrigerator it is CHF 40 (in 2004). The SENS project team, with representatives of producers, retailers and recyclers meets twice a year to review the operations and set the recycling fees.

3.2.2. Advance Recycling Fee (ARF) over Pre-Disposal Fee (PDF)

Recycling fees can be collected at two points – at the time of purchase, or at the time of disposal. In the Swiss system, both SWICO and SENS charge advance recycling fees. The Swiss ARF is in fact an intergenerational contract between appliances purchased in the past and those that are purchased in the present, akin to a pension system. The fees collected in the present are used to pay for appliances purchased in the past and being disposed of now. Similarly, when the appliances purchased today are disposed of in the future, their recycling cost will be met by the fees charged on a new generation of products being sold at that time.

As the system is a consumer rather than a shareholder financed system, from a psychological point of view, a customer is far more willing to pay a small fee charged at the time of purchase than paying for the disposal of a product that is worthless. Also, the financing is more secure because the fee is collected in advance thereby preventing the illegal disposal of e-waste which would be done to avoid paying a disposal fee.

A criticism of the advanced fee is that it penalises rather than promotes products with environment friendly designs. As the advanced recycling fee reflects the costs incurred to pay for products manufactured previously, no consideration is given to new generation products which incorporate special materials or features that make the product more environmentally friendly to recycle at the end-of-life. In comparison, a pre-disposal fee would more accurately reflect the cost of disposal of an end-of-life appliance. In addition, critics argue that setting an intergenerational fee needs accurate estimations of how much waste will be generated and how many new products will be sold, and wrong estimates could potentially destabilise the system.

However, despite its drawbacks, the advance recycling fee was considered more consumer-friendly, more likely to ensure compliance and thereby secure the financing of the system. In fact, SENS started with charging a pre-disposal fee – the vignette – for refrigerators, but later changed in favour of the ARF.

3.2.3. Visible fee vs inbuilt fee

A visible advance recycling fee is one that is explicitly mentioned as an additional component in the price of the product. On the other hand, on a product with an inbuilt fee, the product price includes the fee, without explicit information on the value of the fee. A visible fee, at the time of purchase, is a simple and efficient way of making the system transparent to the consumer as well as creating awareness – so that the consumer knows that the recycling has already been paid for. It is also to prevent unscrupulous retailers or recyclers from charging money for taking back WEEE. The visible fee also creates a level playing field for all manufacturers and retailers, making it impossible for undercutting prices on recycling fees.

In Switzerland by law (Ordinance on the Publication of Prices, 1978), retailers are required to inform customers about the final price of the product, which would include the ARF. Though this does not oblige them to display the amount of the ARF included in the price, the PROs recommend that retailers indicate the included ARF in order to inform the consumers and create greater awareness.

The Swiss system shows that when disposal costs of e-waste are higher than the recoverable value, a recycling fee can successfully fill the financial gap. More importantly, it shows that the legislation governing the collection and disposal of e-waste does not have to specify how the gap should be filled. The ORDEE does not stipulate whether a recycling fee is to be charged or not, or who should pay how much or when. The advantage of letting market forces dictate the financing of the system is a more responsive system that is able to adapt quickly to shifting market dynamics. Additionally, without financial stipulations, the system is more competitive because it gives producers and PRO's the choice on how to secure financing – how much to charge and when – for the take back and recycling.

Policy makers need to be cautious in applying the financing mechanism of Swiss system directly to their WEEE management strategy. For one, it may not be applicable in all countries that the disposal costs of e-waste are higher than recoverable value. In countries where collection costs are lower, the recoverable value might exceed the collection costs, thereby eliminating the need for additional recycling fees. Also, complimentary control mechanisms need to be in place to ensure the transparent collection and utilisation of the recycling fees. If not, there is the danger that unscrupulous agents could abuse the system by charging recycling fees from the consumer for proper disposal, but instead selling the e-waste to recyclers who pay the highest price and not necessarily follow sound disposal practices.

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3.3. Getting the collection logistics right: what should the scope and logistics arrangement of the system be?

The logistical implementation of an EPR policy is a hotly debated topic, especially when it comes to whether it should be an individual or collective take back system, what should be done about historical and orphan products whose producers have ceased to exist and which products to bring under the EPR purview. These questions are raised often by both policy makers and producers when formulating EPR based policies. We elaborate the Swiss experience in organising the scope and logistics of the system.

3.3.1. Collective vs individual take back

A collective take back system is all-inclusive that does not differentiate between different brands of a product type. On the other hand, individual take back systems are brand-specific, catering only to different products of one particular producer.

In Switzerland, all PRO systems are all-inclusive, collective take back systems. The advantages of adopting a collective system are two-fold. Firstly, for a small country like Switzerland, this allows for better efficiency by building economies of scale. Secondly, and more importantly, a collective system is more consumer-oriented, taking into consideration consumers' habits, who would find it more convenient to bring all their various e-waste items to one place rather than have to go to different places for different brands. Consumers tend to think in terms of types of waste – small electronic goods or large household appliances – and not in terms of brands when disposing old equipment. Consequently, individual systems, or brand-specific collection systems, would be extremely inconvenient for a consumer, having to dispose different brands at different locations or at different times. For collectors and retailers it would also incur an unnecessary effort to separately collect and store appliances according to different brands.

As an example of the high costs incurred in individual take back system, we would like to point out that two major hardware manufacturers, who have individual take back programs for their printer supplies, reported spending an average of CHF 7 in postal charges alone for every returned cartridge. In comparison, the ARF on a whole printer including all consumables for its entire lifetime, which may cost up to CHF 1000, was only CHF 6 (in 2004).

Advocates of individual systems point to the danger of free riders in a collective system, which would over-burden and hence undermine the whole system. However, the most important argument for an individual system is that it would give companies a chance to get feedback on their products and help in improving product design, which is often considered as a pre-emptive solution for many environmental problems. Eco-design strategies can improve environmental performance over the life cycle of products by lowering energy consumption, by appropriate material selection, by avoiding the use of certain substances and by optimising product characteristics for end-of-life treatment (Van Hamel and Brezet, 1997). The WEEE recycling system of Japan has partially incorporated this aspect where producers have individual responsibility. Individual producers have the physical responsibility for the take back and sound recycling treatment of their end-of-life equipment (Tojo, 1999). This in turn allows them to charge a recycling fee that reflects their investment in better design, whereby products that are designed for disassembly, or with more environmentally sound material composition have lower recycling fees as compared to others. However, in practice, it was seen that other than a few exceptions, most manufacturers charged identical recycling fees on similar appliances following the lead of Matsushita (Yamaguchi, 2002) and have now established two industry groups – one led by Matsuhita and Toshiba and the other by Sony, Mitsubishi, Hitachi and Sharp– to carry out their responsibility (Tojo, 2003).

Therefore, we feel that both collective systems and individual solutions have their drawbacks, and both involve trade-offs. In the Swiss case, it was considered that the logistical complications of collecting individual brands far outweighed any cost benefits that a firm may have had by preventing free riders. The argument that individual solution would provide greater feedback loop to the design table, while very desirable, was considered a weak argument for implementing an individual system as many products in the current waste stream were found to be several generations older and fast changing technology had moved far ahead since their date of manufacture.

3.3.2. Point of collection

In the reverse logistics chain, the point of sale is the ideal point of take back. The Swiss ORDEE also makes it mandatory for retail outlets to take back e-waste from end consumers free of charge. Retail take back is viable because of several benefits it provides. Firstly, retail outlets already have a storage and transportation logistics chain in place. Secondly, their wide coverage and easily accessible locations makes it easier for consumers to dispose of their e-waste correctly. For the retail outlets, by providing the take back service, they get an opportunity to build their customer relations.

However, perhaps the most important function of the retail outlets is to act as the first filter to segregate working and functional equipment from the broken and unusable. The retailers have the choice, and the competence, to decide whether the appliance can be reused in part or whole, i.e. function recovery, or whether it is should go for final stage of material recovery. It is important to note that only retailers have this authorisation from the PRO to reuse and resell equipment that has been brought back for disposal. In any case, there is little reuse taking place as the PROs estimate that less than 2% of collected e-waste is being reused. However, little scientific data regarding reuse rates were found, and is therefore difficult to provide accurate estimates.

Additionally, SWICO and SENS also provide a network of collection points situated at some railway stations and community collection centres to make it easier for consumers to dispose of their e-waste. Unlike retail outlets, which have to take back e-waste for free without any compensation, the collection points get paid by the PRO's for the e-waste collected at their

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sites. Also, recyclers act as collection points where consumers can drop off their WEEE.

Because of the wide coverage and choice provided by the combination of both retail outlets and collection points, the Swiss system is able to collect 9.8 kg/capita per annum which is much higher than the EU's WEEE directive target of 4 kg/capita. [Based on the 2004 annual collection figures of SWICO and SENS (72,784 tons as given in Table 5) and the population size of 7,418,400 inhabitants by the end of 2004 (ECOPOP, 2004)].

3.3.3. Historical & orphan products

Historical products – those that have been sold in the past prior to the implementation of EPR legislation, and orphan products – those whose producers have ceased to exist – are an important source of concern for policy makers and companies. In an individual collection system, these products could be hugely problematic, especially in the case of orphan products. However, the current SWICO and SENS systems which accepts all types of electronic and electrical products irrespective of the brands, or when they were sold, eliminates the need to differentiate historical and orphan products.

While in growing markets, where more electronics are sold than returned, such a system would not be a cause for concern. However, in the opposite case, that is when more products are disposed than purchased, it could lead to potential problems of who pays for what and how much. However, given the growth that the electronics and electrical equipment market has seen over the past decades, the chances of such an occurrence are negligible. Nevertheless, the PROs maintain a reserve of six months operational expenses to overcome any shortfall in the financing due to increasing waste loads and/or decreasing sales. This would ensure sufficient time to re-adjust the fee structure without affecting the functioning of the system.

3.3.4. Industry coverage

Ideally, an e-waste management system should be as comprehensive and inclusive as possible. In determining the scope of the program, the consumer's ability to distinguish the difference between the products covered by the system and those outside it should be considered. An e-waste management system that covers all similar products avoids confusion among consumers and prevents free riders from taking advantage of the system. However, given that electronics and electrical products span such a wide array of industries – from consumer electronics to telecommunication to household appliances – it can be a challenge to get a consensus from all.

In Switzerland, EPR started only with the office IT equipment makers forming SWICO and SENS handling only refrigerators. However, both SWICO and SENS increased the scope of the product categories under their purview over a period of time, often going though long negotiating processes with producers. SENS' negotiations with the producers of household goods alone took longer than expected and resulted in the postponement of their new system by a year.

The scope and logistics of the Swiss system demonstrates that an all-inclusive collective system, which uses the strength of the existing retail outlets can be successfully and efficiently implemented. While it requires time to achieve wide-ranging industry coverage, the SWICO and SENS systems show that it is possible to start with a limited base of product categories and build the system by getting buy-in from other producers, once the system has proved to be beneficial. However, policy makers must remember that there are many economic, demographic and geographic factors in the case of Switzerland – a developed country of 7 million residents, with a small and largely mountainous geography – which may not be applicable to all countries.

3.4. Ensuring compliance: how does the system ensure compliance of the various actors?

One of the biggest challenges of an EPR system is that of producers who evade their responsibility – that is the free riders who enjoy the benefits of the system without paying for it. Not only producers, but other stakeholders such as retailers and consumers who have a part to play in the smooth functioning of the system, can also be prone to shirk their responsibilities. To ensure the continuity of the system therefore, it is essential that all the actors comply so that the chain remains intact. In the following discussion, we look at how the Swiss system overcomes the disruptive forces of free riders, un-cooperative retailers, inactive consumers and rogue recyclers.

3.4.1. Free riders

At the outset, it must be clarified that we do not claim that the Swiss system has no free riders. To be sure, both SWICO and SENS have to contend with the problem of some producers being free riders. However, both PROs estimate that membership in the system is generally high, with only a minor percentage of producers in specific product categories not participating in the system and being largely limited to small producers with insignificant volumes. The high rates of participation in the system can be attributed to a combination of several factors, which act as a multi-point control mechanism.

Firstly, Switzerland imports almost all electronic and electrical goods, therefore the first point of control is at the customs. This makes free riding difficult for importers/manufacturers since it is possible to compare import figures and the ARF received.

Secondly, large electronic and electrical goods retail chains insist that their vendors already be a part of the recycling system before carrying their products. Therefore, for the manufacturer/importer, to gain market access, it becomes imperative that they subscribe to the PROs. In addition, the low cost of participation in the system and the ease of compliance which it offers is a huge incentive for the producers.

Thirdly, even though intangible, peer group pressure is a very important means of reducing free riding. Because all producers stand to benefit from fewer free riders, the PROs use their current members as advocates of the system and also to report non-compliance.

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Lastly, there is the legislative backing provided by the ORDEE, which makes producers legally responsible for the take back and safe disposal of WEEE manufactured/imported by them and in case of non-compliance, face penalties. ORDEE Section 2, Article 4: ''Manufacturers and importers must take back free of charge WEEE of the brands manufactured or imported by them''.

Understandably, the high rates of participation that are prevalent currently (in 2007) took time to achieve. For example, when the SWICO system started, a major hardware manufacturer decided not to take part in the system. However, in the e-waste collected, there were substantial amounts of discarded products of the particular manufacturer. SWICO approached the particular producer and asked them to pay for the recycling costs incurred on their products. Realising that the cost of collection and recycling, as well as the administrative overhead incurred on implementing an individual solution would be far higher than through the collective SWICO Recycling Guarantee, the manufacturer joined the system in 1996. In another example, a large supermarket chain, though only a small EEE retailer, not wanting to participate in the PRO systems and pay the ARF on its products, has the burden of proof to report to the government proper collection and disposal of its equipment to the government. The take back and recycled volumes as a percentage of imported EEE documented by the retailer have to be similar to the rest of the system to be deemed satisfactory, failing which the government can take further legal action against such free riding producers.

3.4.2. Un-cooperative retailers

Section 2 of the ORDEE legally obliges EEE retailers to take back, at least for free, WEEE from private consumers. At the onset, there were concerns that EEE retailers might refuse to take back WEEE, or charge consumers for the take back. Small retailers were concerned that their stores would be flooded by returned products for which they did not have the infrastructure. Another source of worry was that retailers might offload large quantities of their e-waste onto other retailers.

However, the experience of the past decade has shown that because of multiple channels of return provided in the system, there is no undue pressure on the retail infrastructure. SWICO data shows that while retail take back played an important part in the initial phase of the system, it peaked in 2002 when more than 30% of the total quantity collected came through the retail channel. Thereafter, the share of retail outlets in total quantity collected has declined, with collection points becoming the more preferred channel. Retailers instead find that take back is also a way of providing additional service and an opportunity to build customer relationships.

The experience of the retailers and PRO has been satisfactory, with complaints about retailers not taking back discarded appliances for free being extremely rare.

3.4.3. Consumer inaction

The ORDEE stipulates that it is the responsibility of the consumer to bring products to designated places so that they may be disposed properly. Both the SWICO and SENS systems ensure that it is convenient for a consumer to bring back unused appliances to these designated points – either retail outlets or collection centres. By making this return free of cost at the point of disposal, the consumer has little incentive to dispose the appliance illegally. A study in 2001 by SAEFL (2004a) found almost no e-waste in municipal solid waste. Of the few pieces of e-waste found in household waste, most were cables and wires. An important reason for this could be that the Swiss household waste collection system is pay-per-use, with users having to purchase special garbage bags with the disposal tax built into the price of the bag. A reason for this may be that free of cost disposal of WEEE is preferred to purchasing expensive garbage bags for its disposal.

Significantly, neither is e-waste seen being disposed in the open or in forests. The factors that could point to the low incidence of e-waste open areas are the high level of awareness and concern for the environment in the population as well as a habit of segregating at source various kinds of waste before disposal.

3.4.4. Rogue recyclers

The ORDEE does not stipulate any specific recycling or recovery targets for the WEEE recycler, instead allowing the industry to decide the best practices that ensure a reasonably feasible system that balances economic and environmental efficiency. However, Articles 1 and 3 of the ORDEE implicitly imply a maximum recovery target, by ensuring that WEEE does not enter the municipal refuse (Article 1) and that the collection and that the actors are obligated to ensure proper take back and disposal, as well as export for disposal (Articles 1 and 3). In addition, Article 6 in the ORDEE and the Technical Ordinance on Waste (ToW) specify requirements for disposal, including waste that may be admitted for deposition on landfills and incineration.

The ToW imposes strict requirements on the materials sent to landfills and incinerators for disposal, subject to a long list of procedural requirements of licensing, registration and supervision.

In Switzerland, the PROs take on the responsibility to ensure that the licensed recyclers appointed by them meet stringent quality procedures and norms. Rogue recyclers such as those who do not follow environmental, health and safety standards, illegally ship their waste to other countries for processing, or for dumping therefore have the risk of having their contracts with the PROs cancelled thus their material supply cut-off and their licences revoked.

The quantity of e-waste coming into the system is controlled by corresponding weight of pallets picked up by transporters from retailers and collection points to those received and processed by recyclers. This acts as a control on both transporters as well as recyclers. An additional benefit is that it helps the PROs gather data at multiple points to be able to improve the logistics chain.

Both SWICO and SENS employ external auditors to perform technical controls on recyclers. The third party auditors ensure greater transparency regarding the quality of recycling,

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which is especially important for companies implementing ISO 14000 norms. The technical controls ensure that the recycler has no more than 20% of the incoming e-waste unprocessed at the end of the year. The technical audits are also important to evaluate recyclers at the time of renewing their contract, which comes up for renewal every two years.

There is often criticism that the recycling fee paid to recyclers is too high and does not reflect the value of the raw material in line with increasing global metal prices. However, since the recycling contracts are reviewed by external auditors and need to be renewed every two years through competitive bids, market dynamics like changing metal prices are taken into consideration before awarding the contract.

Switzerland has achieved a high level of compliance among all stakeholders – producers, retailers, consumers and recyclers. Cooper (2000, pp 124), also stresses the point about compliance being stronger when all the stakeholders are satisfied about the equity of the system and provide proactive support and compliance resulting in effective implementation.

This shows that it is possible to overcome one of the biggest criticisms of a collective EPR system – free riding. Also, it has shown that for recyclers to maintain their quality, it is a need for independent control and monitoring. For policy makers, it is important to understand that, for an EPR based e-waste management system to function smoothly, it is imperative that all there is a high level of compliance of all the actors – right from the manufacturer to the recycler. While legislation does act as a deterrent, on its own it rarely ensures compliance. Switzerland has tangible and intangible exogenous factors such as the strength of the organised retail sector, the enforcement of legislation by the authorities, transparency in entire material and financial value chain, as well as high consumer awareness levels regarding environmental issues, all or many of which may not be available to all policy makers. Nevertheless, what is commonly applicable to policy makers is that they need to enlist the support of all stakeholders to ensure a smooth and efficient system, irrespective of exogenous factors.

3.5. Restricting monopoly: how does the system prevent the abuse of monopoly powers?

EPR may in certain cases result in firms abusing a dominant position and indulging in price fixing and anti-competitive behaviour, which results in inefficiency (OECD, 2001). The waste management and recycling fields in particular have always been connected with the problem of monopolies (Lindhqvist, 2000). In the case of a collective PRO system, there is the threat of the PRO becoming a monopoly player. Also, a large recycler might corner the entire WEEE waste stream and drive out smaller recyclers, thereby creating a monopoly. We look briefly at how both PROs and recycler monopoly is checked in Switzerland.

3.5.1. PRO monopoly

Both SWICO and SENS are not-for-profit organisations and do not have the goal of a profit-maximising corporation. Nevertheless, concerns regarding monopolistic behaviour of collective systems have been raised often (Tojo, 2003; Van Rossem et al., 2006). The Swiss Federal Competition Commission's enquiry into the PROs in 2005 raised no anti-trust objections, thereby clearing them of any monopoly practices (WEKO, 2005). According to the ORDEE, the PROs do not have the specific mandate for the collection or organisation of the system. The ORDEE merely outlines the essential guidelines, leaving the implementation to the producers who have the choice of either participating in the PRO or setting up a parallel system.

Therefore, the producers do not have the obligation to join the scheme, and do so only voluntarily, as they benefit from economies of scale. In short, transparency regarding the collection, financing and contracting processes helps alleviate the concern' of PRO monopoly.

3.5.2. Recycler monopoly

At present (in 2006), SWICO contracts 15 and SENS contracts 27 licensed recyclers which ensures that there is competition among the recyclers. Of these, there are only two large mechanised recyclers, while the rest are smaller recycling companies engaged in mostly manual dismantling and decontamination, often with a social duty for their employees who are on social support and looking for suitable employment opportunities.

It is in the best interest of the PROs to have a competitive recycling market because the largest part of their expenses is on account of recycling charges. Therefore, both SWICO and SENS take several steps to prevent recycler monopoly.

The SWICO system, which grants the rights to the lowest bidder (who quotes the lowest charges per kg WEEE recycled), prevents large firms from becoming a monopoly player by restricting territorial rights to recyclers who can show that the transport distances are, on an average, 30 km or less, from the collection points/retailers to the recycling facility.

The SENS system uses an average system to fix recycling prices. It receives recycling quotes from all the licensed recyclers, and then based on these quotes, fixes a price which is then applicable to all recyclers. The choice of the recycler is left to the retailer, as all recyclers receive the same rate for the e-waste they process.

The experience of e-waste management in Switzerland has shown that it is possible to design a waste management system which overcomes the threat of monopolistic practices. For policy makers, it shows that rigid regulation is not required to create a competitive environment for both the take back as well as recycling services.

4. Conclusion

From the above discussion, we find that there are lessons that can be learnt from the Swiss experience in using EPR for e-waste management. It was seen that a small group of large producers is sufficient to a critical mass to get the system

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started, even before legislation is introduced. Both producers and policy makers benefit from this as it is possible to develop a flexible yet inexpensive system. Ensuring financial security for a producer responsibility system is especially crucial when disposal costs are higher than the recoverable value, and the Swiss experience showed that a nominal recycling fee can be used effectively to meet the differential and ensure the continuity of the system. Closely linked to this aspect is the inclusiveness or exclusiveness of the system, wherein the Swiss system suggests that an all-inclusive system which does not differentiate between brands, and utilises the strength of the retail distribution network for the reverse logistics helps keep complexity and costs down. A high level of compliance among all stakeholders is necessary to overcome free riding. This can be achieved through independent control and monitoring, and the joint effort of all the stakeholders by providing several checks and balances, ranging from hard legislation to soft peer pressure. The threat of monopoly players in the recycling market can be minimized even without rigid regulations, by ensuring market competition through auctions, territorial restrictions and quotas.

In Switzerland, there is very little e-waste that goes as municipal solid waste and the material cycle is relatively closed; all the stakeholders have a well-defined and equitable role to play and it is a transparent system with very low administrative costs. These are some of the characteristics of good EPR programs as mentioned by Lindhqvist (2000) and OECD (2001).

However, there is still scope for improvement in the Swiss system, as it provides little incentive to producers to design more environmentally friendly products or to consumers to influence buying habits. In addition, the functional reuse is low in Switzerland, both at the product as well as at the component level. Another area of improvement is to increase material recovery, especially for plastics. Also, there is scope for bringing down recycling charges, and thereby ARF on products, especially in a market of rising metal prices. To some extent this is ongoing, as can be seen in the recycling charges paid to the recycler, which started at a high as CHF 2.50 per kg, and have progressively come down to CHF 0.40 per kg in 2007, and as a result, so has ARF on many products.

There is no doubt that the popularity of EPR as a public policy tool is growing. Nevertheless, the concept of EPR remains controversial, with its environmental effectiveness and economic efficiency contested (Hanisch, 2000). Schwartz and Gattusto (2002) argue that not only do EPR programs have conflicting goals, but also the fee setting is generally a political rather than a scientific or economic exercise. Therefore, there is an urgent need for empirical studies to understand the benefits, weaknesses and applicability of EPR based policies. Comparing different EPR policies for different waste streams could help providing answers to why EPR policies are more suited to particular waste streams and why some countries are able to adopt and implement EPR legislation more effectively. Also, there is much scope for research regarding the need for analysing the environmental benefits and costs of recycling electrical and electronic products, especially for smaller, less hazardous fractions of the WEEE stream. A study by Huismain, 2004 on cell phone recycling in Sweden showed, counter intuitively, that the direct smelter route is clearly the most eco-efficient processing option for discarded cellular phones, versus the commonly practiced disassembly and segregation of the circuit boards and other fractions. Such studies would be very helpful for policy makers in defining scope and prioritising the most toxic and hazardous WEEE categories to tackle. As e-waste management deals essentially with stocks and flows, modelling techniques could also prove useful for policy makers to understand the dynamics of these systems and how policy interventions might affect them.

This paper has attempted to shed some light on how an EPR policy has been implemented and the issues that need to be considered. While our study uses experiences on e-waste management from Switzerland, there are several other countries such as Sweden, Norway, Belgium, the Netherlands and Japan, to mention a few, that have incorporated producer responsibility based e-waste management policies. A comparative study of the various countries would provide an interesting area of enquiry as to how these countries differ in their implementation of EPR and the lessons that can be learnt from them.

Finally, we would like to stress that there is no single model of EPR which can be universally applied to either a waste stream or a country, given the host of unique endogenous and exogenous factors that need to be considered before framing policies. Therefore, even in the European Union, which has a common WEEE Directive, the national treatment of the Directive has resulted in many different models of EPR based systems.

The aim of the article is not to suggest any one best model, but rather use Switzerland as an example to discuss some key issues and provide policy makers with crucial insights from experiences of implementing an EPR based e-waste management system in other countries.

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Vitae

Deepali Sinha-Khetriwal has a masters in international management from the University of St. Gallen, Switzerland and a bachelor in economics from the University of Pune, India. Currently based in Mumbai, India, she is the local project coordinator for the seco-sponsored e-waste initiative, and has been associated with the project for more than two years. She continues to work in the area of e-waste management while also researching for her PhD.

Philipp Kraeuchi has been with the Swiss Federal Laboratories for Materials Testing and Research Empa since 2002. He is working in the field of Environmental Informatics within the unit Information Systems and Modelling. His background lies in Environmental Sciences and Information Technology. He was working for several years at the Swiss Agency for the Environment, Forests and Landscape SAEFL and as an IT consultant. He holds a master degree in environmental sciences from the Swiss Federal Institute of Technology ETH.

Rolf Widmer received his M.Sc. in electrical engineering and his MBA for development co-operation from the Swiss Federal Institute of Technology in Zurich (ETH). For several years he was with the Institute for Quantum Electronics at the ETH. Recently he joined the Technology and Society Lab at Empa in Switzerland, a research institution belonging to the ETH domain. He manages the project 'Knowledge Partnerships in e-Waste Recycling', which started in mid 2003. Before that he mainly worked in the field of rural energy supply in developing countries based on renewable energies. He has managed technical co-operation projects in several countries and headed the R & D department on control systems at entec ag, a Swiss company he co-founded and which specializes in decentralized hydro power for rural energy supply. Rolf Widmer is the author of several publications in this field.

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