E-waste take-back system design and policy approaches

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Solving the E-Waste Problem (StEP) White Paper

E-waste Take-Back System Design and Policy Approaches

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E-waste Take-Back System Design and Policy Approaches

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1 Introduction

End-of-life (EoL) electronics have garnered significant interest among policy-makers because they are a waste stream with a unique combination of characteristics. First, levels of EoL electronics, or "e-waste", have been increasing and are expected to continue on this path [1]. Second, e-waste contains materials that are considered toxic, such as lead, mercury and cadmium, which have led to increased environmental concern about improper disposal of these products. Third, there are valuable materials in e-waste and recovery of these materials can alleviate mining of virgin materials. For example, a metric ton of EoL personal computers contains more gold than that recovered from 17 tons of gold ore [2]. Finally, in many cases the costs of recycling e-waste exceed the revenues generated from the recovered materials. This is primarily due to the difficulty of separating highly commingled materials in complex products.

These concerns have led policy-makers across the world to create systems to collect and process e-waste, also known as "take-back systems". The Asian countries of Japan, Taiwan and South Korea have developed mandatory e-waste collection laws. Furthermore, the Member States of the European Union (EU) have recently completed transposing the Waste Electrical and Electronic Equipment (WEEE) Directive, which requires original equipment manufacturers (OEMs) to be responsible for the collection of EoL electronics. The European Member States join other European countries, such as Norway and Switzerland that have similar programmes. North America has experienced a rapid increase in e-waste legislative activity within the past three years. As of September 2008, seventeen US states and four Canadian provinces had already implemented systems or approved legislation creating electronics recycling systems [3]. Legislative activity in the US is rapidly increasing: 79 pieces of e-waste legislation were introduced in 33 states in 2007, compared with 54 bills introduced in 27 states in 2006 [3].

While it is laudable that policy-makers should resolve to address e-waste issues, they often lack the knowledge and practical experience required to create efficient new take-back systems for EoL electronics. The current in-place systems are nascent and many were developed concurrently without the benefit of learning from existing systems. This leaves policy-makers and system architects in the unenviable position of creating systems that are essentially experimental in nature – they must use policy instruments that are new and have not been well-tested. A tangential result is that there is a patchwork of different implementations of e-waste take-back systems in many states and regions.

There is a need for a consolidated source of

of information on EoL electronics take-back system design that would summarize design alternatives and highlight their strengths and weaknesses. The primary objective of this White Paper is to address this need by providing guidance to policymakers and system architects on the policy tools, configuration alternatives, financing schemes and management alternatives that may be used to operate such systems.

This document begins with a description of the generic structure of a take-back system, followed by details on the alternatives available to fulfil each component of the system and strengths and weaknesses of various alternatives. A list of key considerations in system design and examples of current system models is included at the conclusion of the document.

2 Take-Back System Structure

A take-back system has three main functions, depicted in Figure 1 collection, processing and system management. These designations refer to specific goals of the pro-

grammes and all viable systems comprehend all of these functions. The financing scheme encompasses all of the functions and enables the system to be executed.

Financing Scheme

System Management

Collection   Processing
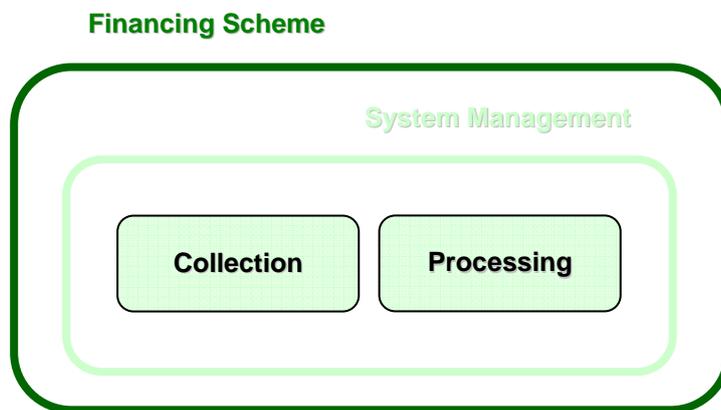
Figure 1: Main functions of a take-back system

A system architect must define implementation modes for these four components, which will depend on the goals of the system. Some common goals for e-waste systems include:

- Motivate OEMs to improve product recyclability, reduce the use of toxic materials and integrate these concepts into product design.

- Prevent toxic materials from entering landfills or being incinerated.

- Recover scrap materials from the products, thereby avoiding the environmental burdens associated with producing virgin materials.

- Ensure that e-waste is processed in an environmentally and socially responsible manner.

- Share responsibility among stakeholders.

- Motivate consumers to hand in equipment.

- Create an efficient and sustainable system.

A fundamental challenge in creating any system is balancing potentially conflicting goals to try and create an optimal system configuration. The following sections describe modes for accomplishing system functions and financing schemes, with the

exception of the processing function. The technical aspects of processing e-waste are covered extensively in the literature [e.g., 4] and system architects do not typically make decisions related to these aspects, aside from generic processing requirements (such as export bans or environmental, health and safety guidelines). The modes

modes described for collection, system management and financing schemes are modular: they could be used individually or in combinations. Key considerations and insights are included after descriptions of the modes to illuminate strategies for connecting system goals with implementation mechanisms.

3 Collection

The primary modes for accomplishing collection are: permanent drop-off facility, special drop-off events and door-to-door pick-up. The mechanism for accomplishing a mode depends on the stakeholder responsible for collection, which could be a government, retail, OEM or commercial entity. A government entity could include a municipal or state department responsible for collecting waste. Retailers sell electronics

in brick-and-mortar stores. Commercial entities involved in collecting e-waste are generally electronics recyclers, but could also be generic waste collectors. OEMs are the manufacturers of electronic products. A summary of typical collection mechanisms for four stakeholders are listed in Table 1, followed by more detailed descriptions.

	Government	Retail	Commercial	OEM
Permanent Drop-Off Location	Co-located with offices or other hazardous waste drop-off locations	Located at retail stores	Located at entity	Location created in partnership with one of other three stakeholders
Special Drop-Off Event	A one- or two-day event dedicated to generators dropping off e-waste at a location affiliated with the stakeholder			
Door-to-Door Pick-Up	Curbside pick-up	N/A	Direct pick-up, particularly from other commercial entities	Pick-up by mail or logistics company

Table 1: Definitions of typical collection mechanisms for various stakeholders

3.1 Permanent Drop-Off Facility

These facilities offer a location for generators (people discarding end-of-life electronics) to drop-off e-waste year-round. Permanent drop-off facilities are often associated with government entities, such as

municipalities. These facilities are typically co-located with other hazardous waste drop-off sites or offices of departments responsible for collecting waste. A retailer could locate a drop-off facility within its store and a commercial entity, such as a recycler, could accept e-waste from generators at its facility. An OEM-

affiliated drop-off point is typically created in partnership with one of the other three stakeholders.

Any permanent drop-off facility must be capable of storing some e-waste, because recyclers will rarely collect the e-waste on a daily basis. Rather, transportation to the recycler will occur when the waste can fill a truck or when the hauler can include a pick-up in its schedule.

3.2 Special Drop-off Events

These are generally one- or two-day events dedicated to generators dropping off e-waste at a location affiliated with the stakeholder. They can be held at a temporary location (e.g., a parking lot) or a permanent facility. Publicity is a key component of maximizing the effectiveness of special events and it serves a dual purpose of increasing collection amounts and educating the public on e-waste recycling options.

Government, retail and commercial stakeholders are the most likely to organize special events, often in collaboration.

3.3 Door-to-Door Pick-Up

The mechanism for door-to-door pick-up is highly dependent on the stakeholder doing the pick-up. Some government entities have curbside pick-up services in conjunction with pick-up of other complex durable goods such as white or brown goods. For example, most municipalities in the US state of Massachusetts offer curbside pick-up of cathode ray tubes for a fee, which is used to offset collection and recycling costs (there is a ban on landfill disposal of CRTs). Commercial entities often use direct pick-up as a collection mechanism, particularly when collecting e-waste from other commercial clients who generate significant volumes of e-waste (i.e., business-to-business, or B2B interactions). However, economic incentives may create situations where some commercial entities engage in door-to-door pick-up of e-waste from consumers, as is the case in the US state of California.

OEMs also use door-to-door pick-up as a mechanism for take-back of their own products. Consumers make a request to an OEM for pick-up of an EoL product. The OEM then works with a logistics provider, such as FedEx or UPS, to pick up the product from the consumer. The product is then shipped to the OEM or an OEM-approved recycling partner.

4 System Management

A take-back system does not run itself: an entity must be responsible for coordinating the actions of various stakeholders and enforcing the system rules and regulations. This system manager may be one of several different types of public or private entities that are outlined in this section.

4.1 Government

Government entities may be tasked with managing take-back systems. In particular, government agencies that handle environmental affairs are typically given the additional responsibilities associated with supervising system operations. These responsibilities might include collection fees, reimbursing collectors and processors, setting and enforcing treatment standards, enforcing sales bans on OEMs, who do not comply with take-back system laws and approving processors and collectors to take part in the system. Government entities may be tasked with supervising a single take-back system for an entire region or multiple systems within a region, but the former is typically true. Fee collection from consumers may necessitate the par-

ticipation of another government agency to collect fees at the point of sale.

4.2 Third Party Organizations

The management of take-back schemes may be carried out by a third party organization (TPO), which provides the management and administration of a recycling programme for its members. The TPOs membership may be made up entirely of manufacturers of the products being recycled, but it can include government entities and other members such as recyclers or collectors. Alternatively, it may be a single entity created by the government to manage a system.

Activities carried out by TPOs, or compliance schemes, vary from country to country, depending on specific legislation requirements, but also depend on services offered to members. In addition to organizing take-back activities, some TPOs provide legal or consultancy services on related topics or compliance services for other flows of waste like packaging or batteries.

The way TPOs manage day-to-day operations depends on:

- Number of other (competing) TPOs in the country: When many TPOs are responsible for collection and treatment of discarded electronics, especially if the same categories of products at collection facilities are managed, a coordination issue needs to be addressed.

- Coordination mechanisms between TPOs: Different approaches could be established, varying from split of territory of the country, a central coordination system that allocates pick-up from collection points depending on relative market share of TPOs or other algorithms, or pure competition, leaving substantial problems related to cherry-

picking effects and proper coverage of territory.

There are two different approaches TPOs may take that accomplish different objectives: own-branded TPOs and non-own-branded TPOs.

Sometimes the creation of TPOs is considered as implementation of a "collective approach", in contrast to an individual approach. It should be noted that the degree of collectiveness can be separated into two different levels: the operational level and the financial level.

The discussion on how to achieve individual financial responsibility even in a collective operational approach introduces a further complexity element to be addressed and discussed at a later stage.

(i) Own-branded

The aim of an own-branded TPO is to collect and treat members' products only. This is in line with the principle of Individual Producer Responsibility (IPR), as a member of the TPO has direct control over its discarded products on the operational level. When the methods for allocating financial responsibility correspond to the return share of products per brand, the IPR principle is fully achieved.

(ii) Non-own-branded

The aim of a non-own-branded TPO is to collect and treat products irrespective of the brand of members and arising waste.

A non-own-branded TPO could be seen as the implementation of a "collective approach" as no relationship exists between members and products collected and treated by the TPO. The TPO could process a share of arising e-waste, depending on the number of other TPOs established in the country, and allocate financial responsibilities among members according to dif-

ferent models (i.e., unit-based, weight-based, fixed % on sales, etc.).

Non-own-branded TPOs are the large majority of those established around the world, as even TPOs established by a group of OEMs are nowadays not only collecting products of their members but rather a share of e-waste arising in the countries where active.

4.3 Original Equipment Manufacturers

Some producers have established individual product stewardship programmes. Under such scenarios two different options exist:

(i) A product recovery network, which includes its own recycling infrastructure and refurbishment or recycling programmes to process own appliances. The OEM has full control over opera-tions and a direct involvement in the entire process.

(ii)   Service providers are contracted in order to collect and treat the OEM's proprietary discarded appliances. The level of engagement of the OEM is determined by the contractual agreement and can vary from full oversight of the process to insignificant engagement in how the contracted operations are performed.

The OEM individually responsible approach is more common for commercially owned and leased (B2B) products that are quite often refurbished or taken back to recover components or spare parts. The two options presented under this scenario can be easily distinguished as the level of involvement of OEMs is quite different. The second option described is more common than the first one.

5 Financing Schemes

Financing of downstream e-waste activities and allocation of economic responsibilities along the downstream chain has proven to be challenging in countries with existing take-back schemes and in countries discussing potential take-back system architectures. The way stakeholders financially contribute to different activities varies and many models exist.

From a general perspective, there are three main stakeholders who could bear responsibility for end-of-life electronics products:

- The entire society. As e-waste is a societal problem, having impact not only on consumers but also on the entire population (both in terms of environmental and societal impacts), systems could be financed by the entire society (i.e., by taxpayers), especially when government organizations keep control over operations.

- The consumers. This could be seen as an implementation of the "polluter pays principle", where the polluter is recognized as the person responsible for discarding an end-of-life appliance. It could also be argued that even though a producer may bear financial responsibility, consumers will eventually pay the end-of-life costs as an increase of the product price, even when no up-front external charges are paid at point of sale.

- The producers. This is implementation of various degrees of the extended producer responsibility principle. It should be noted that although the financing of systems is ensured by producers, internalization of costs in the product price can arise by means of:

  o A reduction of the producer's sales margins, resulting in the financial

impact fully borne by the producer, or

o An increase of sales price, resulting in the financial impact indirectly borne by the consumer.

The choice between a reduction of sales margins or an increase in sales price is not strictly dependent on the financing model of the entire system, even if advocates of EPR speak primarily of cost internalization as a reduction in margins – notwithstanding different costs and margins structures for different products exist. Such choice involves many complex issues and depends on each company's strategy and product portfolio.

The definition of financing models is critical to understanding the design and operation of e-waste take-back systems and is necessary to clearly assess many basic principles of the financial management of compliance schemes. Furthermore definitions are necessary in order to:

- Assess the financial flows (this issue is related to the financial responsibility of stakeholders and, in particular, of producers and final users. It is also related to the assignment of responsibility based on various metrics - i.e., put on market by weight, unit or value, or by return shares, etc.).

- Assess the impact on stakeholders and compliance with legislative requirements.

- Assess the economic and financial effectiveness of any compliance scheme in comparison with itself and with others over time.

The relationships among the stakeholders involved in a system and the financial flows are specified by financing models. Based on the differences in the operative and financial structures of systems in place around the world, it's possible to define at

least four generic financing models. These models identify the relationship between stakeholders (i.e., between producers, compliance scheme and final users) and the level of responsibility of the system managers.

5.1 Compliance Cost

In a Compliance Cost model, producers finance activities in the system, bearing costs for management of all e-waste (for example, by joining a compliance scheme, financing their own take-back system or product stewardship programme). A producer financing its own take-back programme is quite rare, especially considering that the electronics industry has a large variety of companies and many of them, particularly small and medium-sized ones, do not have the organizational and financial capability of setting up such systems.

In the great majority of cases, producers join a compliance scheme and pay a specific amount of money, which covers the costs of take-back and recycling programmes and all other services the scheme is willing to provide. The cost could be unit-based or weight-based and is assessed by the scheme on the basis of actual recycling costs or estimation of future costs.

Schemes usually assess compliance costs on the basis of fees charged by treatment plants and logistics partners. The costs are normally revised during the year and adjusted quarterly, annually or in accordance with specific statements in the contracts between the compliance scheme and the producers. In a collective approach contracts specify that producers who are active in the market in a specific year pay for management of e-waste arising in that year according to their present market share or their return share.

Specific agreements can be established regarding the way historical waste (i.e.,

waste arising from appliances put on the market before the e-waste legislation was enacted) is financed. Since no retroactive obligations can be established, the burden of financing historical waste is usually shared, in addition to orphan waste, which is financed collectively by those producers active in the market in any given year.

The Compliance Cost model includes direct involvement of producers as stakeholder in the financing of the system.

5.2 Compliance Cost & Visible Fee

In a Compliance Cost and Visible Fee model, producers finance activities in the system, bearing costs for management of waste they put on the market (for example, by joining a compliance scheme or financing their own take-back system). They also bear costs for management of e-waste put on the market by other producers in the past (i.e., historical waste) but they use a so-called "Visible Fee" to generate revenues from final users to cover historical waste management costs.

The Visible Fee mechanism has been introduced by the EU WEEE Directive as a means for producers to share the burden of financing historical waste with consumers. The model combines two different financial mechanisms for the two separate flows of appliances (i.e., new and historical).

The Compliance Cost and Visible Fee model includes direct involvement of producers as stakeholders in the financing of the system at least with respect to appliances put on the market under their responsibility (i.e., after e-waste legislations were enacted). However, producers are allowed to share financial responsibility with consumers to cover the costs of historical waste.

5.3 Reimbursed Compliance Cost

In a Reimbursed Compliance Cost model, producers finance activities in the system by bearing costs for management of e-waste (for example, by joining a compliance scheme or financing their own take-back or product stewardship programme). They also bear costs for management of historical waste, but they use a Visible Fee mechanism to generate revenue from final users to pay for all e-waste management costs. Producers pay compliance schemes in advance when placing appliances on the market but are reimbursed for the costs when selling appliances to final users.

The Reimbursed Compliance Cost model includes direct involvement of producers as stakeholders in the financing of the system, but only via an up-front payment made when appliances are placed on the market. In the end consumers are financing the entire system by paying the Visible Fee.

5.4 Recycling Fee

A Recycling Fee, also known as a Recovery Fee, is paid by consumers when they buy new equipment. Hence the consumers bear the costs for management of e-waste; there is no financial involvement of producers.

A Recycling Fee could be used to raise funds for future treatment of appliances currently being sold. This means that the future recycling costs for each appliance is estimated in advance and paid up-front by the consumer when buying the appliance.

Alternatively, the Recycling Fee represents and is calculated as a share of actual costs of recycling arising WEEE. This means that recycling costs currently arising are shared among appliances being sold.

The main difference between the two options is that in the first case the amount paid by the consumer represents an up-

front estimation of costs arising in the future, whereas in the second case appliances sold contribute, by means of a fee, to the financing of current recycling costs. In both cases there is no direct financial involvement of producers in the system: end users are bearing end-of-life costs.

5.5 End-of-Life Fee

An end-of-life fee is paid by generators of e-waste (i.e., the last owner of a product who decides to recycle it) to an entity who assumes responsibility for recycling the EoL product. The fee covers collection and recycling costs.

5.6 Other Hybrid Implementation Models

The models presented in this chapter do not represent the only solutions, but rather define fundamental approaches. Hybrid models of these approaches are possible. However, the main objective of defining

these models is to identify the boundaries for financial responsibilities in the system in terms of:

- General financing responsibilities: The Compliance Cost and Recycling or End-of-Life Fees models represent the opposite ends of the spectrum (i.e., producers fully responsible vs. consumers fully responsible). The first model could also apply in the case of societal responsibility (taxpayers bearing costs), where the role of producers is taken by any governmental organization financed by the state's budget.

- Options to share responsibilities with other stakeholders: The Visible Fee mechanism is one method for sharing responsibility, especially with respect to historical or orphan waste, because it is difficult to justify retroactive financial responsibility.

6 Key Considerations

There are several key considerations that system architects should take into account when designing a take-back system. These will help to determine which mechanisms are chosen to accomplish system objectives.

- Scope of products collected: Adding more product types can improve revenues for recyclers and lower overall processing costs, but can also increase the complexity of the system by increasing the collection burden and the number of stakeholders, particularly producers, who are participating in the system.

- Collection from commercial entities: Once again, adding volume to the system has the aforementioned positive and negative aspects. Furthermore, there is a

philosophical debate regarding whether commercial entities should be financially responsible for treating their e-waste.

- Number of collection points: Consumers would ideally have limitless possibilities of locations for taking-back EoL equipment and it is safe to assume that a higher number of collection points results in higher return rates. However, there are costs and burdens associated with hosting collection points and these must be considered when collection locations are selected.

- Treatment standards: There is a large variety of environmental themes in the collection and processing of e-waste per treatment category due to different sub-

stances of environmental concern, such as mercury-related toxicity from LCD monitors and gas discharge lamps; ozone-layer depletion and global warming potential for refrigerators; and cumulative energy demand and resource depletion for refrigerators and CRT screens. (for detailed information per environmental impact category on this subject see [1]). Furthermore, many stakeholders have concerns about e-waste being treated in the developing world in unsafe working conditions. Treatment standards may be instituted for a system to address many of these concerns, but they may result in higher processing costs and administrative enforcement costs.

- Collection targets: Goals can be an effective tool for increasing collection amounts but it can be difficult to determine realistic goals agreed upon by all stakeholders.

- Reuse: For a large number of products, reuse is environmentally-preferred over recycling, but there are risks that treatment financing is applied multiple times to the same product.

- Allocating return share: Certain producer responsibility financing models require brand tracking of EoL products, either via an actual count of all brands returned or statistically valid sampling, in order to determine OEM financial responsibility by return share. While this is an accurate method of determining return share, the brand tracking adds administrative cost.

Several challenges arise from trying to deal with these issues and it is important to consider the influence of e-waste policy on:

- Harmonization of requirements for producers and recyclers with respect to reporting, operations and technologies to be applied.

- How to deal with different business models and business sectors as well as differences between professional and consumer equipment.

- Position of reuse: To be incorporated in e-waste policy or elsewhere in design related legislation and the connected social aspects.

- General stakeholder awareness of specific responsibilities: It was found in the EU, for instance, that large numbers of small and medium-sized enterprises (SMEs) are not even aware of their current legal obligations.

- Realization of the policy: Determining the amount of descriptions and targets to place in (inflexible) laws and what to leave to the industry for operational standards.

- Enforcement of the provisions: Market surveillance by governments to ensure that obligations are met by the relevant stakeholders.

6.1 Stakeholders Responsibilities

Given that e-waste is a societal problem, it demands a societal solution where all stakeholders contribute in line with their positive influence on the solutions side, with more focus on maximizing collection performance and improving treatment quality. This leads to the following table addressing such **potential** responsibilities:

Stakeholder	Lessons from eco-efficiency studies/system implementations worldwide
Legislators	Adhere to "better regulation" and "minimizing the administrative burdens" principles: For example, in the EU, 27 different transpositions and interpretations of the WEEE Directive have led to high costs, disorder, delays and lost focus on the original environmental intent. Increasing harmonization can improve compliance and avoid free-riding. Enforcement is essential to avoid free-riding, illegal exports and low quality of treatment and to create positive incentives for collection.
Producers	Producers have three types of responsibilities: Financially: Whatever financing mechanism is applied for the collection categories with net costs, the mechanism itself should not promote doing less. Organizationally: Producers are the only stakeholders with global organizing capabilities. More development of transnational or even global approaches should be welcomed that improve economies of scale, recycling knowledge and better collection and treatment. Product design: From an eco-efficiency perspective, design should be focused on avoiding specific recycling "accidents". It is challenging to design away net collection and recycling costs. Furthermore, it is difficult to establish a design feedback loop that includes old appliances collected (sometimes 20+ years old) and new products. All design-for-recycling-motivated product design changes should be evaluated from a life-cycle perspective to ensure that end-of-life considerations are balanced with other eco-design principles.
Take Back Systems/ Compliance Schemes	Develop a joint strategy and positioning towards an "Ideal WEEE Framework" based on compromise instead of debating individual issues separately. There are no one-size-fits-all solutions for all WEEE. Solutions tailor-made for different sub-sectors (IT, CE, White Goods, Lighting equipment) have completely different environmental priorities and economic models as well as incomparable breakdowns of take-back costs. Realize economies of scale: Educate consumers to hand in old products, make logistics efficient and aggregate treatment and auditing standards for recyclers. The introduction of market instruments that encourage positive competition for more collection should be further researched.
Municipalities	Maximize collection: Avoiding illegal trading and "cherry picking". Provide easily accessible, free of charge collection points for consumers. Mandatory hand-in to compliance schemes can decrease (illegal) trading of collected goods. Furthermore, educate local consumers on easily accessible waste collection points.
Retailers	Maximize collection: Better retail involvement means more service to consumers with more easily accessible collection points and a direct fulfilment of producer obligations for their own-branded products. An "all-for-all" take-back mechanism should be considered: selling a product category means take-back of any type of equipment free of charge with an obligation to forward collected waste to compliance schemes.
Recyclers	Develop "best available" technologies and practices for the recycling sector, particularly monitoring practices for outgoing material fractions. Avoid illegal secondary trading with its associated adverse environmental effects by installing and complying with transparent substance flow monitoring and reporting.
Consumers	Maximize collection: Hand in old products. Consumers will pay in the end, regardless of whether costs are made visible or internalized.

Table 2: Key stakeholder responsibilities in a take-back system

7 Examples of Current System Models

There are e-waste take-back systems in place all over the world, which utilize different mechanisms to accomplish their objectives. Descriptions of a few selected systems are included below to demonstrate some of the decisions made by system architects.

7.1 California, USA

- **Scope:** The scope of products covered in the system (and charged an ARF) is centred on display devices including: monitors (CRTs and LCDs), TVs (all types, including CRTs, Plasmas and LCDs) and laptops. The system accepts e-waste from commercial generators.

- **Collection:** Collection is conducted by collectors approved by the Department of Toxic Substances Control (DTSC). These generally include government (i.e., municipalities) or commercial entities who use permanent collection facilities, special events and door-to-door pick-up to collect e-waste.

- **System Managers:** All government entities: the California Integrated Waste Management Board (CIWMB), the Department of Toxic Substances Control (DTSC) and the Board of Equalization (BOE). CIWMB is responsible for recycling reimbursement and public education, while DTSC is responsible for recycling oversight and enforcement and BOE is responsible for fee collection.

- **Financing Scheme:** Consumers pay a recycling fee that ranges from 6-10 USD, but will increase to a range of 8-16 USD on 1 January 2009.

- **Processing:** Approved processors must meet a set of treatment standards in order to participate in the programme.

They must have an environmental management system (EMS), including occupation health and safety and hazardous material management systems, and documentation must be provided on all down-stream material destinations. Audits of processors may be conducted at any time. Processors are allowed to export collected products if they notify DTSC in advance of the destination and the means of recycling there.

7.2 Maine, USA

- **Scope:** The scope of products covered in the system includes: monitors (CRTs and LCDs), TVs (all types, including CRTs and LCDs) and laptops. The system does not accept e-waste from commercial generators.

- **Collection:** Collection points within Maine consist entirely of municipal permanent drop-off locations and special events.

- **System Managers:** The Maine state government's Department of Environmental Protection (DEP) reviews and approves a limited set of "consolidators" who are allowed to bill manufacturers. The DEP also monitors the programme by setting processing standards, checking compliance and educating the public about the programme.

- **Financing Scheme:** Producers pay a Compliance Cost that is equal to cost associated with the transportation and processing of all of their returned products. The brand of every collected product is documented by consolidators in order to determine the OEM compliance cost. Municipalities are responsible for costs associated with collecting e-waste and transporting it to a consolidation facility where product brands are documented. Municipalities may charge e-waste generators to cover their costs.

- **Processing:** Recycling standards for Maine processors are similar to California's (an EMS in place, regular audits, "due diligence" in selecting downstream material destinations), including documenting export destinations.

7.3 Minnesota, USA

- **Scope:** The scope of products covered for manufacturer responsibility (defined as "video Display Devices or "VDDs") includes: monitors (CRTs and LCDs), TVs (all types, including CRTs and LCDs) and laptops. The scope of products accepted in the system (defined as Covered Electronic Devices or "CEDs") includes: computers, peripherals, facsimile machines, DVD players, video-cassette recorders and VDDs. The system does not accept e-waste from commercial generators.

- **Collection:** Collectors register with, but are not approved by the Minnesota Pollution Control Agency (MPCA) and consist of an amalgam of government (e.g., municipalities, county governments) and commercial entities who use permanent collection facilities, special events and door-to-door pick-up to collect e-waste. In addition, many recyclers offer direct collection through their own facilities or large collection events at public sites.

- **System Managers:** The MPCA registers manufacturers, collectors and recyclers but does not manage payments to collectors/recyclers. Manufacturers are individually responsible for collecting a defined amount of CEDs each year and can carry out that responsibility individually or collectively. At least one manufacturer TPO was formed, but many manufacturers chose to work directly with recyclers in the first programme year to fulfil their pounds goal. Manufacturers face penalties for under-

collecting their goal, but may also carry over excess pounds for up to three years in the future.

- **Financing Scheme:** Producers pay a Compliance Cost that is equal to cost associated with the collection, transportation and processing of their market share. Minnesota calculates market share based on the weight (not units) sold in the state annually. Retailers are obligated to report in-state sales back to every manufacturer in order to make this calculation. Manufacturers are responsible for collecting an amount of CEDs equal to 80% of the weight of the VDDs they sell in the state each year. Municipalities may also charge e-waste generators to cover their costs.

- **Processing:** Manufacturers are responsible for ensuring "due diligence" in selecting recyclers, but no standards are specified as of yet.

7.4 EU

- **Scope:** The scope of the WEEE Directive embraces the great majority of domestic electronic products (large and small household appliances, Consumer Electronics and ICT equipment as well as lighting) and even some specific professional or dual use appliances such as electronic tools, automatic dispensers or monitoring equipments.

- **Collection:** Collection points within different EU Member States consist of municipal permanent drop-off locations and retailers. Retailers accept discarded appliances from final users on an "old-for-new" basis: when a consumer buys a new, equivalent appliance the consumer has the right to hand in the old one free of charge at the location of sale. In some countries (i.e., Denmark) retailers have the right not to accept on old-for-new basis, but when deciding to provide the

take-back service to consumers they accept on an "any old, per type of equipment" basis: this means that any consumer could enter an establishment providing the take-back service and hand in any electronic device when the shop is selling such type of equipment. The same mechanism is in place in Norway and Switzerland.

- **System Managers:** Different TPOs are responsible for different take-back activities. When different TPOs are operating on the same waste flows, clearing houses or coordinating models are in place to ensure a level playing field for all players on the market (i.e., Italy).

- **Financing Scheme:** In the great majority of Member States, a Reimbursed Compliance Cost model is in place. Producers pay a fee to TPOs on a weight or unit basis, depending on specific agreements, and set the same fee amount as the Visible Fee towards for the final users. This means that the Visible Fee covers both historical and new waste flows as no split is possible. Such a financing mechanism is often called "pay-as-you-go" and reflects a collective approach based on actual market share of producers on the market in any given year.

- **Processing:** There are specific treatment requirements defined in the WEEE Directive (Annex II) as well as some voluntary industry standards (i.e., EERA, WEEE Forum CECED) developed for specific flows (i.e., cooling and freezing appliances containing Ozone Depleting Substances).

7.4.1 Belgium, EU

- **Scope**: The scope reflects WEEE Directive Annex 1.

- **Collection**: For household goods all Belgian citizens are expected to bring used goods either to re-use centres (available in the three regions) for sec-

ond-hand selling, retailers (old-for-new basis) or to a broad network of municipalities (518 in 2007). For commercial WEEE there is a take-back obligation for manufacturers and/or importers in the three Belgian regions (Flanders, Brussels and Wallonia). The discarders of commercial WEEE (B2B) are responsible for the collection and transportation to licensed (by the regions) treatment facilities.

- **System Managers**: There is no official registration body in Belgium (this is under development). For business-to-consumer (B2C) collection, each producer has the obligation to become a member of Recupel, which is the only collection scheme approved and supported by the government. Recupel was founded by the manufacturers and importers of electrical and electronic equipment as a non-profit organization with the support of the Belgian regional governments. The system came into force on 1 July 2001. For B2B collection manufacturers and importers have the choice either to join Recupel or to setup an individual waste management plan. This plan gives the government detailed information on how the financing, collection, recycling and reporting will take place, and has to be approved by the three regions.

- **Financing Scheme** For household appliances a visible fee is charged (on the invoices). This fee is used to finance the costs for the collection, sorting, transport and treatment of discarded appliances. For all commercial appliances the discarder bears all related costs which includes collection, transportation, treatment, administration and reporting to the three regions. An administrative fee is charged to producers who join Recupel for B2B collection when their product is put on the market. This fee is used only to cover reporting and administrative costs.

- **Processing**: Recupel and all individual players (i.e., discarders of commercial WEEE) have the responsibility to use only approved transportation companies and treatment facilities. Treatment facilities for electrical and electronic waste need an official license. Recognition by the regional authorities is required for the transportation of WEEE. Official lists are published. More than 90% of household WEEE collected in Belgium is processed in Belgium.

7.4.2 France, EU

- **Scope:** The scope reflects WEEE Directive Annex 1.

- **Collection:** There are three ways through which e-waste can be collected in France: through retailers and the old-for-new principle (10,300 collection points at the end of 2007, 2,300 for light bulbs); by using permanent municipal drop-off facilities (2,000 collection points in more than 500 municipalities covering more than 40 million people); and through donations to non-profit organizations (Emmaüs, ENVIE, Ateliers du Bocage, etc.).

- **System Managers:** Four TPOs ("eco-organisms") have been approved by law to collectively manage e-waste (Eco-systèmes, Ecologic, ERP and Recylum which has the monopoly on light bulbs). They have been created by producers to manage all e-waste (not an own-branded approach), and they are in charge of both operational and financial aspects of the scheme. For example, to collect and to treat e-waste they select service providers following a call for tender. They are coordinated by the OCAD3E, a joint subsidiary of the four TPOs aiming to coordinate the relationships between the four eco-organisms and local authorities, to compensate local authorities

cal authorities which have chosen to set up specific recycling schemes, and to ensure homogeneous coverage of the territory. It is running a working group on Ecodesign led by HP.

- **Financing Scheme:** France adopted the Compliance Cost and Visible Fee system, which commenced operation on 15 November 2006. Distributors transfer the exact amount of the visible fee they have collected from consumers to producers, which pay a subscription to TPOs. How much do they get out of the visible fee? According to the head of the main TPO, Eco-systèmes, which has captured more than 70% of the market, Ecosystèmes receives 81 euros per ton from producers, whereas distributors transfer 71 euros per ton to producers (in total, 160 million euros were paid to French TPOs in 2007). The value of the visible fee per product is calculated on the basis of real EoL costs for each WEEE category (life span, treatment costs, TPO's scheme). For example, it is 13 euros for a 300 litre fridge.

- **Processing:** Services providers selected by TPOs treat the WEEE collected by local authorities and distributors following rules set by the 20 July 2005 decree regarding reuse, decontamination, recycling and recovery. These providers are paid by TPOs with the money collected from the subscription that producers pay to TPOs.

7.4.3 Germany, EU

- **Scope:** The scope reflects WEEE Directive Annex 1.

- **Collection:** Before a producer is permitted to introduce a new product to the market, it has to register with the Federal Environment Agency. A condition for the registration is the constitution of a financial guarantee covering the cost

of sound disposal of household appliances it plans to introduce. The main responsibility for the management of WEEE is with the producer.

The producer's obligations include:

o Providing the containers in which the public collection sites have to separately collect WEEE.

o Organizing the transport and treatment of WEEE from the public collection site to the treatment facilities.

o Controlling whether old appliances can be reused.

o Removal of certain substances, according to the WEEE directive.

o Informing consumers about the possibilities and the necessity of a sound management of WEEE.

o Report relevant data to the clearing house.

Those who dispose of WEEE must discard WEEE separately from the municipal solid waste stream.

Discarders of non-household WEEE - be it historical or new - may arrange diverting solutions with the producer.

- **System Mangers:** The Federal Environmental Agency was entrusted with the implementation of Germany's Electrical and Electronic Equipment Act and the registration of producers and importers. The designated clearing house is the Old Electric Appliances Register Foundation. Its main role is the supervision of the transport of WEEE from the collection site to the treatment facility. It is the focal point of information concerning the management of WEEE for public authorities and the private sector and it supports decision-making. The law provides that the clearing house be constituted with a council whose members are producers, retailers, public entities responsible for disposal, federal and state representatives, and consumer and environment protection associations. The clearing house has to be equally accessible to all producers. The competent authority of each federal state organizes the collection of WEEE.

- **Financing Scheme:** The producers are to finance the collection from the public collection sites and the disposal. The collection of household WEEE has to be free of charge, whereas the collection of non-household appliances may be done for a fee.

- **Processing:** The clearing house decides on the attribution of an appliance to one of the five categories and calculates the respective volume of WEEE (including historical WEEE). Each producer is responsible for an amount of WEEE according to its market share. Once a municipality reports that a certain volume of WEEE is collected, the clearing house determines the producer responsible for the transport and treatment of the reported volume of WEEE. Furthermore, the clearing house has an obligation to inform the general public of disposal possibilities. It must also report the collected data to the Federal Environment Agency. It is not allowed to conclude or arrange contracts with disposal-enterprises.

7.4.4 Ireland, EU

- **Scope:** The scope reflects WEEE Directive Annex 1.

- **Collection:** Members of the public are entitled to deposit household WEEE at Civic Amenity (C.A.) facilities operated by or on behalf of local authorities free of charge. Each producer, or any party (i.e., collective compliance scheme) acting on their behalf, must make adequate arrangements for the collection of WEEE from designated collection points and Civic Amenity facilities in the functional area of each local authority. Local authorities can

designate retailers' premises as collection points, subject to the agreement of the retailer concerned and, where appropriate, an approved collective compliance scheme retailers, when supplying a new product, must accept back WEEE from private households free of charge on a one-to-one basis as long as the WEEE is of equivalent type or has fulfilled the same function as the supplied equipment. Retailers of EEE, with the agreement of the appropriate local authorities, may make alternative arrangements for ensuring that the collection obligations are discharged on their behalf by a nominated distributor, a group of distributors or a third party acting on their behalf.

- **System Managers:** The WEEE Register Society was set up to assist producer companies in meeting their obligations for the responsible management of WEEE. The principal functions of the Society include: registration of producers and importers of electrical and electronic equipment, notifying the Environmental Protection Agency (EPA) where there is evidence of non-compliance with the regulations, verification of visible Environmental Management Costs (vEMC) and determination of the market share of individual producers. In addition, two TPOs have been established to take care of the collection, treatment and recycling of WEEE in Ireland on behalf of its producer members. WEEE Ireland is the largest of two authorized national compliance schemes for electrical and battery recycling in Ireland with over 500 members, covering over 80% of the geographic area of the Republic of Ireland. The second scheme is ERP (European Recycling Platform) Ireland with approximately 20% geographic coverage and 75 members.

- **Financing Scheme:** Provision for inclusion of Environmental Management Cost (vEMCs) in the retail price of EEE was introduced in regulations. These vEMCs fund the recycling of WEEE and/or batteries or accumulators collected from designated civic amenity and retailer sites nationwide. The WEEE Register Society Limited, the national registration body for producers, has determined the vEMC per category and subcategory of EEE. The vEMCs displayed to consumers cannot exceed the actual costs of recycling, are assigned for recycling activity and are not diverted elsewhere. The vEMCs are calculated on the basis of the estimated number of electrical and electronic appliances that will be recovered.

- **Processing:** According to WEEE Ireland, approximately 80% of the material collected on behalf of the scheme is primarily processed on the island of Ireland with the remainder going to dedicated WEEE treatment facilities in the UK and mainland Europe. ERP offers a recycling service (only logistics and collection/treatment) through Geodis, its general contractor in Ireland. All further processing takes place overseas. The EPA is responsible for enforcing producers' and treatment operators' compliance with the regulations.

7.4.5 Italy, EU

- **Scope:** The scope reflects WEEE Directive Annex 1.

- **Collection:** Collection points consist of municipal permanent drop-off facilities as well as retailers on an old-for-new basis. Retailers have the right to bring appliances collected from consumers to municipal drop-off facilities. Currently the take-back obligations of retailers, as

as well as their right to hand in the appliances collected at municipal collection points, have been delayed until the publication of a further decree aimed at simplifying the waste management legislation on storage and transportation of WEEE from retailers.

- **System Managers:** Fourteen TPOs have been established to fulfil take-back obligations from household WEEE. TPOs need to join the national clearing house aimed at ensuring a level playing field. The clearing house will establish for each TPO, depending on market share, which municipal drop-off facilities will be served by each TPO, avoiding any cherry-picking efforts and ensuring a proper coverage of the country by the fourteen competing TPOs.

- **Financing Scheme:** Each TPO has its own financing mechanisms, but the Reimbursed Compliance Cost and the Compliance Cost models are the most frequent. It needs to be highlighted that by law only historical waste is currently collected as all provisions on financing of new waste have been delayed.

- **Processing:** The clearing house is responsible for the definition of a specific agreement with national associations of recyclers to ensure a level playing field and of monitoring that the competing TPOs will establish contractual agreements only with those partners responding to a minimum standard level.

8 References

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StEP White Papers:

Number	StEP Task Force	Title	Date
#1	TF 1 "Policy"	E-waste Take-back System Design and Policy Approaches	28 Jan. 2009

All StEP White Papers are online available at http://www.step-initiative.org/publications/

About the StEP Initiative:

Our name is our programme: solving the e-waste problem is the focus of our attention. Our declared aim is to plan, initiate and facilitate the sustainable reduction and handling of e-waste at political, social, economic and ecological levels.

Our prime objectives are:

- optimizing the life cycle of electric and electronic equipment by
  - improving supply chains
  - closing material loops
  - reducing contamination
- increasing utilization of resources and reuse of equipment
- exercising concern about disparities such as the digital divide between industrializing and industrialized countries
- increasing public, scientific and business knowledge
- developing clear policy recommendations

As a science-based initiative founded by various UN organizations we create and foster partnerships between companies, governmental and non-governmental organizations and academic institutions.

StEP is open to companies, governmental organizations, academic institutions, NGOs and NPOs and international organizations which commit to proactive and constructive participation in the work of StEP by signing StEP's Memorandum of Understanding (MoU). StEP members are expected to contribute monetarily and in kind to the existence and development of the initiative.

StEP's core principles:

1. StEP's work is founded on scientific assessments and incorporates a comprehensive view of the social, environmental and economic aspects of e-waste.
2. StEP conducts research on the entire life-cycle of electronic and electrical equipment and their corresponding global supply, process and material flows.
3. StEP's research and pilot projects are meant to contribute to the solution of e-waste problems.
4. StEP condemns all illegal activities related to e-waste including illegal shipments and reuse/ recycling practices that are harmful to the environment and human health.
5. StEP seeks to foster safe and eco/energy-efficient reuse and recycling practices around the globe in a socially responsible manner.

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