# E-Waste Recycling in Latin America: Overview, Challenges and Potential

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## Abstract

Latin America is facing a rapid increase in internet use along with fast growing computer sales. Penetration with electronic equipment is in some countries approaching the level of industrialized countries. There is an evident need to resolve the management of "end-of-life" computers and other electronic equipment. Several studies in Latin America assessed the increasing e-waste quantities and confirmed the importance of a sustainable e-waste management. This paper gives an overview on the status on e-waste management in Latin America, explains the challenges for establishing an e-waste management system in a developing country setting and highlights the social and economic potential and the possibilities of a regional approach.

## Introduction

Global ICT-trade and generation of e-waste from ICT

The global production of electronic devices and particularly of Information and Communication Technologies (ICT) faces the biggest industrial expansion of the history: OECD figures show that global trade of ICT technologies has reached 7.7% of the gross world product by 2004, the major proportion accruing from China [1]. In 2006 an estimated 230 million computers and 1 billion cell phones have been sold worldwide which corresponds to a volume of 5'848'000 t [2]. As a consequence, Waste from Electrical and Electronic Equipment (WEEE), or e-waste, is by far the fastest growing waste component. It reaches more than 5% referred to municipal solid waste and e-waste generation in developing countries according to UNEP is expected to triple by 2010 [2].
According to the OECD e-waste is "any appliance using an electric power supply that has reached its end-of-life" [3]. The European WEEE directive [4] distinguishes 10 categories of e-waste: Big Household Appliances, Small Household Appliances, IT and Telecommunications Equipment, Consumer Equipment, Lighting Equipment, Electrical and Electronic Tools, Toys, Leisure and Sports Equipment, Medical Devices, Monitoring and Control Instruments, and Automatic Dispensers. In this paper e-waste and WEEE are used as synonyms. Focus will be laid on e-waste from IT-equipment (IT-waste), corresponding to category 3 of the European WEEE-Directive.

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E-waste marks an emerging environmental problem as well as a business opportunity, given the content of both toxic (about 2% of total weight) and valuable materials [5]. While the toxic substances are of low risk during the use phase of the equipment, they can become extremely harmful in the end-of-life phase. Lead in Cathode Ray Tubes (CRT), cadmium and brominated flame retardants in plastics and mercury in flat screen backlights are just a few of the many examples of toxic substances which potentially endanger the health of people and the environment if not dealt with properly. It has been documented in several studies that the dismantling of electrical and electronic equipment in developing countries is done mainly by the poor – without any occupational health and safety measures [6]. As a trigger for these unsuitable practices serve rising metal prices particularly for copper, nickel, gold, silver, iron and aluminium. These extracted metals can be sold locally and will be exported to the world markets.
The share of precious metals contained in e-waste is substantial: It is estimated that in the 230 million computers and the 1 billion cell phones sold in 2006 the quantities of gold and silver reach approximately 70 t respectively 535 t, which correspond to about 3% each of the world mine production for both metals. For palladium these figures even reach 18 t or 12% [7]. One of the main obstacles to efficiently and effectively recover these resources is the almost nonexistent infrastructure for collection and recycling as well as the missing assignment of clear responsibilities.

## E-Waste Generation in Latin America

E-waste generation

Latin America is characterized by a high urbanization rate reaching 75% compared to Asia and Africa with 40% respectively 38%, and a world average of 50% [8]. In line with the urbanization goes a high penetration rate with IT-equipment and a high level of internet use. The latter is estimated to reach 24% in Latin America, but only 14% in Asia and 5% in Africa, whereas the world average reaches an estimated 21% [9].
Even though IT use in Latin America still lags behind their northern neighbours, the region has experienced an almost 600% increase in internet use from 2000 to 2007 [9]. A similar trend can be observed in most Latin American countries in the sales of IT-equipment for the past few years and in particularly for 2007. The digital markets in Latin America have been growing on average 14% between 2003 and 2005, more than twice the rates from Europe and United States (5%) and Asia-Pacific (6%) [10]. Figure 1 provides an overview of the development of penetration rates for PCs between 2001 and 2006 in selected countries of Latin America [11].
The rapid growth of sales of IT-equipment is resulting in increasing quantities of e-waste. Several country studies in Latin America confirm this appraisal by predicting fast increasing e-waste streams:

- An e-waste study for *Colombia* (population 45 Mio) revealed around 6’000 - 9’000 t of computer waste for 2007, a quantity that is estimated to double within the next five years [11]. This figure is in the same range as estimations of 7’300 t/a made for *Peru* (population 29 Mio) [12]. Corporate IT-waste produced by the public and private sector is assessed to be around 50-55% in both countries.
- A detailed assessment for *Chile* estimated 7’000 t for 2007 (population 16 Mio.) with a rate of corporate IT-waste of 65% [13].
- During 2007 in *Argentina* over 20’000 t of IT-waste have been generated according to a recent study (population 39 Mio) [14].

- A similar report from Mexico estimated 28'000 t of IT-waste for 2006 (population 103 Mio) [15].

In spite of the lack of comprehensive figures and a standardized methodology to assess e-waste generation it has to be concluded that Latin America will have to address in the near future the question of disposal of rapidly increasing numbers of end-of-life computers and other IT-equipment. As already stated by Ripley [16], e-waste is reaching critical mass in Latin America.

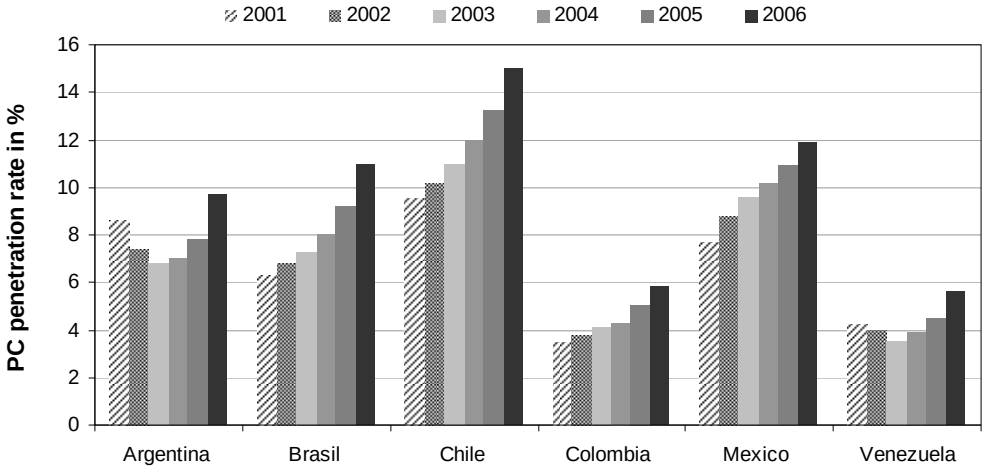


**Figure 1:** Development of the penetration rate of PCs between 2001 and 2006 in selected countries of Latin America [11].

## Policy Principles and Global Framework

Extended Producer Responsibility

Extended Producer Responsibility or EPR is defined by Lindhqvist [17] as a "policy principle to promote total life cycle environmental improvements of product systems by extending the responsibilities of the manufacturers of the product to various parts of the entire life cycle of the product, and especially to take-back, recycling and final disposal of the product." The incentives are twofold: to relieve municipalities of some financial burden of waste management, and to provide incentives to producers to reduce resources, use more secondary materials, and undertake design changes to reduce waste [3]. EPR as a policy principle enjoys meanwhile a wide acceptance by governments and industries. Initially it has been applied for packaging waste and batteries, was later extended to WEEE and recently in the European Union to end-of-life vehicles. As the coverage of EPR is more and more extended to various post consumer waste streams, the range of approaches for implementing EPR is widening. The producer responsibility can vary from fully private models to publicly required ones, sharing in different grades operational and controlling aspects.

The manner in which EPR for WEEE is transposed into legislation and its subsequent implementation differ from country to country, particularly in its scope (all WEEE or only some categories), range and type (collective vs. individual responsibility) and funding mechanisms (financial responsibility and its point of imposition) [18]. EPR is not limited to industrial country settings; also in a developing country context it can be transposed into national legislations and be implemented in different ways. The challenges can be met considering that in developing countries the share of historical products is still low and the share of non-branded products is

often overestimated. Formalization of part of the informal sector is a must, however low-risk operations like collection can be left in part to the informal sector [19].

Corporate responses

In recent years some EPR initiatives of mobile phone producers (for example Motorola and Nokia) have been launched in developing countries. These voluntary take backs schemes concentrate on either mobile phone battery or complete mobile phone take-back only. Computer related initiatives cover printer and toner cartridge take-back actions (by Hewlett Packard and Lexmark). Dell has extended his Consumer Free Recycling programme in 2006 to some countries of Latin America. Collective or individual EPR programmes covering a certain WEEE category regardless of brand and type of equipment have not evolved yet.

Basel Convention and StEP

The "Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal" adopted in 1989 is the international framework for hazardous waste, including e-waste. The Ban Amendment to the Basel Convention from 1995 is prohibiting any export of hazardous wastes from industrialized to developing countries. It has not yet entered into force since it requires the signature of three quarters of the countries which signed the Basel Convention.
The 8$^{th}$ Conference of the Parties (COP) of the Basel Convention in Nairobi declared in 2006 e-waste a priority issue and emphasized the need for creative and innovative solutions for the environmentally sound management of e-waste [20].
Globally standardized recycling processes recovering valuable components in e-waste, extending the life of products and markets for their reuse, and harmonizing world legislative and policy approaches are the prime goals of a global public-private initiative called "Solving the E-Waste Problem (StEP)". This initiative was launched in March 2007 by various UN organisations (UNU, UNEP and UNCTAD) together with industry, governments, donors and academic institutions.

## Regional Agreements and National Legislations

Regional agreements

The Mercosur Policy Agreement from 2006 [21] mandates its member states Argentina, Paraguay, Uruguay and Brazil to take national measures to ensure post consumer responsibility by producers and importers. This policy agreement is a sub regional attempt to anchor the concept of EPR as an environmental policy principle.
The Organization of American States (OAS) has declared in its Santo Domingo conference in 2006 the readiness to prevent and mitigate negative effects associated with the use of ICT along the whole life cycle, particularly pertaining also to an inadequate recycling.

National legislations

*Costa Rica* has stipulated EPR as a policy principle in its recently drafted decree on WEEE. Producers are hold responsible for the proper management of e-waste from ICT. They have to comply with goals set up by a public-private committee which will be formed for implementing

the decree. At present only WEEE categories 3 and 4 (ICT and Consumer Electronics) are addressed.
In 2005 *Argentina* initiated a national plan on integrated e-waste management and in 2006 a project on a specific legislation on WEEE which is supposed to cover the 10 WEEE categories according to the European Directive. In 2007 a third project was proposed to establish guiding principles for companies working in e-waste management. However these proposals have not yet got the political support needed in order to become effective.
In *Brazil* the situation is somehow contradicting between state and federal level. On state level some EPR based waste framework laws have been issued. In Sao Paolo as well as on federal level there seems to be strong opposition from producer's side to include EPR for WEEE management as a guiding principle [16].
In *Peru* in the course of the revision of the national waste legislation the explicit inclusion of the EPR principle is under discussion whereas in *Colombia* the draft of a specific legal framework for WEEE is on the political agenda.

## Refurbishment and Recycling Infrastructure

Refurbishment projects

Projects for computer refurbishment are basically the result of social initiatives aiming at reducing the negative effects of the digital divide trough computer donations. The reference model was the Canadian "Computer for schools" initiative. In this context various initiatives evolved in Latin America which differ in their operational design and coverage. The most successful programme is *"Computadores para Educar"* of the Colombian Ministry of Education which has in 2007 reached 28'000 delivered computers to schools totalling almost 110'000 since its start in 2001.
In most cases the refurbished computers are used to supply public education programmes under the umbrella of the Ministry of Education of a particular country. A strong government support of such programmes has demonstrated to be a crucial factor due to its financial support but also in order to facilitate distribution in public education, to get access to the computers from public institutions, corporate users and external donor agencies and to disseminate positive experiences through public mass media.

E-waste recycling infrastructure

Formal recycling of e-waste in Latin America, mostly limited to a professional disassembly, is an emerging recycling activity. In a number of countries like Chile, Argentina, Peru, Colombia and Brazil traditional metal recycling companies have discovered the e-waste recycling market. Processed quantities are still on a modest level, since neither the political framework, nor the logistical infrastructure is allowing for larger quantities. Most of these companies do not offer a full fledged service since they preferably concentrate on valuable components, like printed wiring boards, disregarding an adequate disposal of components like Cathode Ray Tubes (CRT) or other components which have a negative economic value but pose a potential environmental or health risk.
In Chile formal recycling of IT-waste reaches only an estimated 1.5-3% of the quantities generated [13], a figure which is likely to be similar or even lower in the other countries. Most of the companies concentrate on service delivery to big national and international companies

following a business-to-business (B2B) approach, whereas the informal sector is trying to make benefit of valuable e-waste components from private households.

## International Initiatives

The Basel Convention Regional Centre (BCRC) in Buenos Aires has started an initiative to collect basic information trying to quantify the amount of e-waste generated in the different countries of Latin America and the Caribbean. Consolidated figures are not yet available. In April 2008 the BCRC supported in Colombia a pilot take-back campaign of IT-waste. Similar pilot e-waste collections have been realized earlier in Costa Rica and are now planned for Lima.
The International Development Research Centre (IDRC) through its Institute for Connectivity in the Americas (ICA) started in 2003 a programme on reuse of computers for schools in Latin America and the Caribbean (LAC) in cooperation with SUR, an NGO in Chile. The programme focuses on exploring challenges and opportunities created by shipping obsolete computers from industrialized countries to Latin America. It looks into environmental and social aspects of such ICT transfers, particularly of those dedicated for schools and other educational programmes. IDRC concluded that the reuse and distribution of computers on a large scale requires end-of-life solutions for the obsolete equipment and therefore needs to address recycling aspects too. In a second phase which started in 2007 the programme is now addressing this issue through the creation of a Regional Platform for the management of waste from computer in Latin America and the Caribbean (www.rrrtic.net).
The Swiss Federal Laboratory for Material Testing and Research (EMPA) is implementing the international e-waste programme "Knowledge Partnerships in e-waste Recycling" (www.ewasteguide.info) financed by the State Secretariat for Economic Affairs (seco) of the Swiss Government. In close cooperation with relevant stakeholders from industry, government and NGO the programme is supporting the establishment of sound e-waste management systems in South Africa, India and China. After three years of implementation substantial improvements in e-waste management can be claimed as a direct or indirect outcome of the program: In China the programme supported the development of a national e-waste law and technical standards, and will now accompany their translation into an operable e-waste system in the two cities Hangzhou and Qingdao. In India the cooperation led to the foundation of a national e-waste strategy group which currently develops a producer responsibility concept and to the establishment of first "Clean e-waste Channels" in Bangalore and Delhi. In South Africa the cooperation resulted in the creation of the e-waste Association South Africa out of which the South African IT Association (ITA) launched an initiative to establish a Producer Responsible Organisation (PRO) by the end of 2007; "Green e-waste Channels" started their operation in Cape Town, Johannesburg and Durban. The programme of the Swiss Government is now being prepared for extension to Latin America with Colombia and Peru as focus countries. It will be carried out in close cooperation with the programme of IDRC/SUR.

## Social and Economic Potential of e-waste management

Low risk processes, such as manual dismantling of e-waste offer good job opportunities for low and medium skilled labour given proper training and access to the necessary and affordable technologies [22]. The SWICO system in Switzerland has created around 1'200 jobs in social institutions by recycling around 45'000 t of e-waste from ICT annually. Refurbishment activities have a high potential to generate low and semi-skilled jobs too. The project *"Computadores para*

*Educar"* in Colombia will create in its final stage around 390 low/semi-skilled and about 50 highly skilled jobs with the refurbishment of 46'000 computers annually [23].

## Challenges for a sustainable E-Waste Management in Latin America

Policy and legislation

E-waste management is slowly been taken into the political agenda of some countries in Latin America. However in most countries the present destinies of obsolete electrical and electronic equipment as well as quantitative figures are unknown. Only Mexico, Costa Rica, Colombia, Peru, Argentina and Chile have particular baseline studies available so far.
Specific e-waste legislation is in development in Costa-Rica. All other countries of Latin America still lag behind in drafting a legal framework for e-waste management. While drafting such legislation the roles of both government and industry need to be clarified. Traditional models for solid waste management have assigned the tasks of collection and disposal of waste to public authorities; however, an EPR model requires an adequate assignation and repartition of responsibilities along the reverse supply chain. A participative process in designing the legal framework is therefore a prerequisite of a successful later implementation.

Collection and recycling infrastructure

Waste collection and recycling infrastructure in developing countries is characterized by a high level of informality. A certain level of informality will prevail even when a regulated e-waste management system becomes operational. While formal recycling companies will enlarge their activities and increase the processed quantities when a formal e-waste management system is put into place, informal recyclers will continue to collect from individual households those components with an economic value. A major challenge is therefore to guide the role of the informal sector towards a future system. As a consequence e-waste management systems should incentive individual and corporate consumers to dispose potentially harmful WEEE into formal collection systems. In order to become effective, some sort of financial scheme which compensates return of obsolete equipment will be needed.

EPR in a Latin American context

Latin America is characterized by a wide range of different economical levels which in turn result in different social levels. Given the differences in framework conditions and present waste practices EPR implementation can not be based on a single model approach which is universally applied to either a waste stream or country. In order to get the ICT producers and trade industry committed and to assign responsibilities, strong and responsive trade associations which represent the largest producers, importers and retailers should be in place. In a future e-waste management system such associations can assume the role of a PRO.
Experience has shown that starting an e-waste managements system based on EPR does not imply having all producers and importers on board from the very beginning. A limited group of the largest importers and producers allows to get a system off the ground, even before legislation is put into force [18]. In an initial stage resistance from a PRO towards the inclusion of non-branded ("cloned") and historical products might occur, however the share of such products which could potentially benefit from a system without contributing to its financing is often overestimated [19].

A major challenge now is the implementation of the EPR concept considering the high percentage of cloned computers on the market, where a responsible producer is difficult to identify.
The material value of the discharged electric and electronic equipment is the driving force in an e-waste management system and at the same time represents the key to its financial basis. Producer Responsibility Organisations can benefit from this added value while operating a system. The question whether the intrinsic material value is sufficient to finance a system has been debated widely. However it must be concluded that a full-fledged system which implies the proper disposal of toxic components, an adequate drop-off and collection infrastructure and a control mechanism will require additional financial resources [19].
Furthermore, e-waste management systems for obsolete IT-equipment have to consider the possibility of combing refurbishment and recycling. Reuse of equipment which has not reached its technical lifespan is a precept giving the limited access to information technologies in developing countries. Future systems should therefore integrate refurbishing activities and build on synergies with the respective actors.

## Outlook

In the course of designing a future solution of e-waste management in Latin America different actors will become involved and will be assigned specific roles in that process. A continuous dialogue from the very beginning between the governing bodies and the importers, producers and retailers is a must. Even though further voluntary solutions by some producers will evolve, these will only offer services for single products of a single brand. Such particular approaches will not solve the challenge of growing e-waste streams. Solutions with comprehensive schemes and public-private partnerships will be required. The combination of refurbishment and recycling will offer an opportunity to link socially motivated educational initiatives addressing the bridging of the digital divide with resource recovery and generation of economic activities. E-waste management in developing countries is challenging, but will also provide opportunities for new and innovative approaches.
The potential of regional solutions lies particularly in aligning policy frameworks and treatment standards, in harmonising operational schemes and in controlling the transboundary movements of new and second-hand components and particular e-waste streams. Quality standards for donations directed to refurbishment programmes will be of particular importance. Formal cooperation between corresponding actors should be initiated and regional activities should be consolidated in a regional platform for WEEE management, synonymous to the WEEE forum which has been established in Europe.

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