



Wasting No Opportunity

The case for managing
Brazil's electronic waste

PROJECT REPORT

April 2012



THE WORLD BANK

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Prepared by *infoDev* (The World Bank Group) for the Ministry of Science and Technology (MCT),
Secretariat on Information Technology Policy (SEPIN), Brazil

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Acknowledgements

This report was drafted by local expert Ms. Vanda Scartezini in São Paulo and the e-waste practice of Ernst & Young Paris, led by Mr. Richard Abdelnour. The report is based on interviews, discussions and site visits to electro/electronic industry, professional, and durable consumer goods manufacturing associations, not-for-profit organizations, and federal, state, and municipal governments in Brazil, India, South Africa, and Costa Rica between December 2010 and March 2011, as well as the documents referenced in this study. On November 2010, *infoDev* convened the “International Seminar on Electronic Waste” in Brasília, where the authors presented and invited comments on the preliminary reports assessing Brazil’s current e-waste activities, and a global survey of good practice. In this context, the authors wish to acknowledge the support of Secretary Dr. Gadelha of MCT; Secretary Dr. Silverio of the environment ministry, MMA; Mr. Nitin Gupta, CEO of Attero, India; Mr. Keith Anderson, Chairman of the E-Waste Association of South Africa (presentation in absentia); Mr. Uca Silva, Regional Platform on E-Waste in Latin America and Caribbean; Ms. Cécile Desabbayes, Ecosystèmes, France; Mr. Eric Mugnier, Executive Director, Environment & Sustainability Services, Ernst & Young; Mr. Marcos Pimentel, Ambientronic (Produtos Eletrônicos Ambientalmente Corretos); Mr. Kami Saidi—Diretor de Sustentabilidade Ambiental da HP Brasil, and ABINEE (Brazilian Electrical and Electronics Industry Association); and Mr. Natan Rodeguero, Global Intelligence Alliance—Brazil. The report was drafted with significant contributions by Mr. Francois Auclert, IFC senior Industry Specialist, who agreed to formally peer-review the report.

The project was carried out under the supervision of Josef Trommer (*infoDev*). Valerie D’Costa, Program Manager (*infoDev*), provided overall management guidance for the development of the report. Maria Farrell and Roberto Peña edited the report and prepared it for publication.

This report was requested by the Ministry of Science and Technology of Brazil (MCT) under *infoDev*’s Technology for Inclusion, Innovation and Sustainability Program. The program is a partnership between the government of Brazil and the World Bank Group whose purpose is to advance the innovation, science and technology agenda to contribute to growth and reduce poverty in developing countries.

EXECUTIVE SUMMARY

ELECTRONIC AND ELECTRICAL EQUIPMENT WASTE, 'E-WASTE', IS GENERATED BY A LARGE VARIETY OF APPLIANCES, FROM LARGE HOUSEHOLD APPLIANCES (WASHING MACHINES, REFRIGERATORS, ETC.) TO SMALL ELECTRONIC DEVICES SUCH AS CELL PHONES, COMPUTERS AND CONSUMER ELECTRONICS.

E-waste is growing faster than any other waste stream, driven by a growing electronics market and the rising obsolescence rate of electronic equipment.

E-waste is both a crucial environmental issue and an economic opportunity. The issues raised include:

- Inappropriate end-of-life management of e-waste can create toxic environmental impacts.
- Manual dismantling: persons dismantling electronic and electrical equipment manually may suffer health impacts.
- Landfill: toxic substances present in e-waste can contaminate water sources and ground soil.
- Incineration of e-waste plastics improperly generates harmful dioxins and other chemicals.

The growing e-waste economic opportunity is driven by:

- Valuable components and materials contained in electronic waste (e.g. gold, copper)
- New regulations and Extended Producer Responsibility (EPR) schemes that ensure additional financing for collection and recycling activities.

With its national strategy now being implemented in a policy and legal framework to address the solid waste challenge, and with a formal sector agreement on

e-waste in place, it is time for Brazil to consider its role as a large player in the e-waste global arena.

Key findings

An adequate policy and legal framework, such as the recent federal framework legislation in Brazil, is a fundamental precondition for the establishment of a sound, national e-waste management system.

A policy and legal framework:

- Ends uncertainty and sets out roles, responsibilities and economic incentives among e-waste actors;
- Defines implementation and awareness mechanisms and institutional support;
- Sets out compliance obligations and enforcement measures.

A national e-waste policy should specify the financial responsibilities and set reasonable, progressive and mandatory targets for e-waste collection and treatment. It is the key driver in structuring and driving recycling activities that may not be sufficiently profitable otherwise.

Extended Producer Responsibility (EPR) is currently considered the best approach of three models considered in this study. EPR clarifies roles and responsibilities, disseminates costs throughout the

EXECUTIVE SUMMARY

value chain and stimulates producers to design long-lasting, environmentally friendly and easily recyclable products.

National, sub-national and regional policies are best developed in ongoing consultation and dialogue with industry and other stakeholders. Engaging all the stakeholders is a key success factor. Government, local institutions, producers, importers, retailers, refurbishers, recyclers, dismantlers, scavengers, NGOs and academics need to be involved to invoke their support and share their insights. If the general public cannot practically be included in consultations, it should be made aware of the issues to increase consumer compliance during implementation.

In emerging economies, the biggest challenge is enforcement, as the informal sector will likely remain a major player in the medium term. Considerable efforts need to be made to engage these stakeholders in the national dialogue and implementation, and to ensure there are sufficient resources for proper enforcement.

As collection mechanisms in emerging economies are underdeveloped and still dominated by the informal sector, these countries will struggle to generate high enough volumes of feedstock to sustainably supply the very capital-intensive processing business.

Europe has achieved a first-mover advantage in large-scale semi-precious processing. Currently, there are four large integrated smelters/refineries worldwide that process precious metals in an economically viable and environmentally sound way. Three of these refineries are in Europe (Belgium, Germany and Sweden).

As the largest country in South America, and with a relatively well developed legal framework on e-waste, Brazil could take advantage of the opportunity to collect and potentially import e-waste and develop

the processes and facilities to extract precious materials from it. If successful, this could create a significant number of high-quality jobs in Brazil. The key question is whether Brazil should consider encouraging a capital-intensive refining facility to undertake the processing activities currently exported to companies located outside Latin America. Success at developing domestic refining capacity would depend on long-term investment and scientific cooperation.

Regarding the potential import of e-waste from other Latin American countries, issues to be considered include:

- Relations, interests and agreements with other Latin American countries, and the possible need to harmonize legislation and certification.
- Transport, taxation and administrative issues and legal liabilities, including those specifically related to export of e-waste.
- Border controls dealing with illegal e-waste importation.
- International knowledge-sharing and capacity-building needs.

Careful evaluation needs to be done to determine if the outcome of these activities is likely to be favorable and worthwhile. Any initial consideration of developing highly specialized processing facilities in Brazil should be done on the basis of the likely domestic volume of e-waste feedstock.

Key questions for further consideration include:

- How best costs and opportunities can be spread throughout the life cycle (including a discussion



Photo Credit: George Hotelling

of how much intervention is desirable to determine these).

- How to monitor and enforce implementation.
- Recycling targets for each material.
- Overall impact on the economy.
- The awareness and participation of the public.
- How to gather the right data together to monitor and improve the system.

Recommendations

Success at developing domestic refining capacity would depend on significant long-term investment and scientific cooperation, and require a high volume of e-waste throughput that is not currently feasible. This report recommends that Brazil focus for the immediate future on improving the earlier points in the e-waste value chain.

Brazil should consider the ‘Best of Two Worlds’ model, piloted by Taizhou in China under the United Nations University StEP initiative. In this scheme, simple components are processed locally in China, and complex parts are sent overseas to a specialized, high-volume plant for processing and return.

Brazil should focus on collection and initial processing of electronic waste, including segregation, crushing and disassembly; while sending outputs to one of the four global processors for end-processing and complex treatment (especially for printed circuit boards). These

activities have the best outcome per investment in terms of job creation and environmental impact.

To improve efficacy of collection and export activities, Brazil should consider creating or incentivizing a ‘buffer’ entity to:

- Connect and coordinate smaller regional e-waste flows into larger batches.
- Pay the informal units upfront for amounts collected, (itself receiving financial returns following export).
- Handle compulsory e-waste export and import notification procedures required by the Basel Convention.

Regarding the further implementation of the existing federal framework, the following recommendations are made:

- States should harmonize or coordinate state-level regulation with the Federal Law. It is important that the allocation of costs and responsibilities along the value chain be nationally consistent. Otherwise, necessary investments will not be made and variations will generate unnecessarily high transport costs and associated environmental impacts.
- Training and capacity-building are essential for e-waste policy success, and should be encouraged in tertiary level education as well as basic qualifications and training.
- A consistent and locally cost-effective certification system(s) is needed to provide trustworthy final destination guarantees.



INTRODUCTION

INFODEV (WWW.INFODEV.ORG) IS A RESEARCH, CAPACITY-BUILDING AND ADVISORY SERVICE ORGANIZATION, HOSTED BY THE WORLD BANK GROUP IN THE FINANCE AND PRIVATE SECTOR DEVELOPMENT VICE PRESIDENCY. INFODEV WORKS WITH EMERGING ECONOMIES AND DEVELOPING COUNTRIES AND THEIR INTERNATIONAL PARTNERS TO USE INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTs) EFFECTIVELY AS TOOLS OF POVERTY REDUCTION AND SUSTAINABLE DEVELOPMENT.

Project background

At the request of the Ministry of Science and Technology of Brazil (MCT), an *infoDev* donor, *infoDev* developed a program around the theme: “*Technology for Inclusion, Innovation and Sustainability*.” Through this collaboration, *infoDev* hopes to support Brazil’s transition to a knowledge economy and society, ensure that technology is used for social inclusion and sustainable development, and support Brazil’s leadership in helping less developed countries to emulate its success. The total budget for this program is US\$750,000 of which \$600,000 is from MCT’s contribution to *infoDev* and \$150,000 is from additional resources provided by *infoDev*.

The first part of the program is entitled: “*Brazil: E-Waste Policy & Strategy*.” This project is to develop a recommendation for an e-waste policy for Brazil based on global good practice, and make recommendations to MCT on implementing such a policy. The specific project activities were to:

1. **Assess Brazil’s current e-waste activities and policies**
Comprehensive stocktaking of existing e-waste

initiatives and policies in Brazil and key issues facing Brazil in managing e-waste. Organize stakeholder meetings with public and private sector representatives.

2. **Aggregate global good practice and international collaborative practices in e-waste**

Evaluate global good practice in developing and implementing e-waste policies and identify relevant examples of international collaboration in e-waste.

3. **Develop an e-waste strategy recommendation for implementation in Brazil**

Develop an e-waste strategy recommendation for Brazil, and propose a strategy for implementation.

Production of the report

Project activities commenced in August, 2010, leading to the engagement of national and global experts Vanda Scartezini in São Paulo and the e-waste practice of Ernst & Young, Paris. *infoDev* convened an industry stakeholder meeting in São Paulo, Brazil, on 30 November, 2010. The ‘International Seminar on Electronic Waste’ presented and invited comments

on the preliminary expert reports on an assessment of Brazil's current e-waste activities and a global survey of good practice. This participatory meeting was addressed by then Secretary Dr. Gadelha of MCT and Secretary Dr. Silverio of the environment ministry, MMA. Other scheduled speakers included:

- Nitin Gupta, CEO of Attero, India.
- Keith Anderson, Chairman of the e-waste Association of South Africa (*presentation in absentia*).
- Uca Silva, Regional Platform on e-waste in Latin America and Caribbean.
- Cécile Desabbayes, Ecosystèmes, France.
- Eric Mugnier, Executive Director Environment & Sustainability Services, Ernst & Young.
- Marcos Pimentel, Ambientronic (Produtos Eletrônicos Ambientalmente Corretos).
- Kami Saidi, Diretor de Sustentabilidade Ambiental da HP Brasil, and ABINEE (Brazilian Electrical and Electronics Industry Association).
- Natan Rodeguero, Global Intelligence Alliance, Brazil.

The meeting was attended by approximately 120 industry representatives including manufacturers, importers, retailers and recyclers. The key industry associations were actively present, including ABINEE and ELETROS (Associação Nacional de Fabricantes de Produtos Eletroeletrônicos). The meeting was closed by *infoDev*'s Program Manager, Valerie D'Costa.

Following the stakeholder meeting, an online resource (a 'wiki') was created to allow industry and other stakeholders to provide comments on the draft report from December 2010 to March 2011. Draft report segments were produced by Ernst & Young (Paris), led by Richard Abdelnour, and by Vanda Scartezini, an industry expert in São Paulo, Brazil. A further presentation and discussion of a more comprehensive draft report to a meeting of government and industry at the ABINEE TEC conference was led by Vanda Scartezini in March, 2011.

The draft report was then developed for submission to MCT and a subsequent draft reviewed by World Bank Group subject experts, resulting in this final version. This report is based on original research conducted via interviews, discussions and site visits to the electro/electronic industry, professional associations, durable consumer goods manufacturing associations, not-for-

profit organizations, and federal, state and municipal governments. *infoDev* is indebted to the numerous individuals and organizations who so generously shared their time and expertise for the preparation of this study.

Report structure

The draft report comprises an executive summary, introduction and two main sections:

1. Brazil: Reality, Strategy and Policy Recommendations.
2. Global Benchmarking and Good Practice: International Regulatory Models, Case Studies and Global Policy Recommendations.

The first section focuses on Brazil, analyzing Brazil's situation, the market and the legislation and e-waste chain, the models employed by several companies, and opportunities and challenges for Brazil. It concludes with detailed draft recommendations.

The second section is focused on international practice, legislation and market opportunities. An annex further elaborates the detailed international case studies considered.

Final recommendations will be discussed with MCT and other officials, as well as other national stakeholders, and will be the result of multiple exchanges with interested local stakeholders and verification against international benchmarking and good practices. It is hoped that this may be used as guidance for the establishment of an implementation agreement with the electro-electronic sector in Brazil.

Significant additional resources, including lists and links to manufacturing companies' initiatives, as well as the federal, state, and relevant municipalities' legislation have been prepared but are not included in this draft. They will be published in an annex to the final report, but can be provided directly for reference in the meantime, if required.

Three different approaches were considered and compared in detail:

- Extended Producer Responsibility (EPR)
- Consumer pays
- Mixed model

The global benchmarking study includes international case studies from the following countries:

- India
- South Africa
- Costa Rica
- France

Background

A recent United Nations Environment Programme (UNEP) report highlighted the “urgent need to prepare developing countries for the surge in e-wastes [due to] rocketing sales of cell phones, gadgets, and other appliances.” The report noted that “proper e-waste collection, recycling [are] key to recovering valuable materials, protecting health, and building new green economy...and, unless action is stepped up to properly collect and recycle materials, many developing countries face the spectre of hazardous e-waste mountains with serious consequences for the environment and public health.” The report highlighted Brazil, along with Mexico and Senegal, as “generating more e-waste per capita from personal computers than the other [11] countries surveyed.”

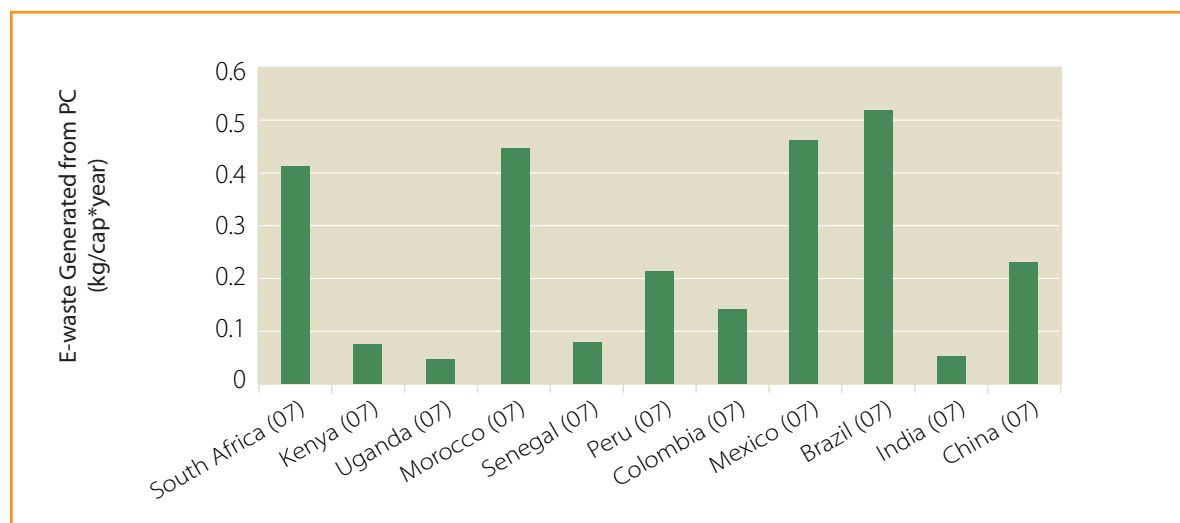
In addition to mitigating the health and environmental risks posed by e-waste, there is also an economic opportunity to reclaim precious metals and other materials for recycling and reuse. To incentiv-

ize such businesses to emerge in this space, an e-waste policy is required. Brazil has recently passed significant national legislation on e-waste, and is now considering implementation measures for its policy framework on e-waste (Federal Law n° 12,305/2010).

The Brazilian electronics and IT market is considered the fifth biggest globally after China, USA, Japan and Russia. Several states in Brazil have initiated e-waste initiatives or are considering e-waste regulations. This year, 2011, Brazil is estimated to produce approximately 6.5 kg/year/inhabitant of e-waste, and the projection for 2015 will reach 8 kg/yr/inh. Currently, Europe produces about 20 kg/yr/inh.¹

In developed countries, e-waste recycling began in the early 1990s, but was mostly limited to large household appliances. Specialized e-waste recyclers then entered the market to increase value from recovery of materials contained in e-waste or in some cases anticipating e-waste legislation. The development of e-waste regulations around the world, in particular in Europe under EU Directive 2002/96/EC, has prompted the emergence of a growing number of players in the global recycling market.

A key issue driving the global market is the availability of e-waste (‘feedstock’) to process, as many processes are not economically sustainable unless driven by sufficiently high volumes. Not every country will produce sufficient feedstock to drive a competitive national market for e-waste processing, and regional or global champions will likely emerge.



Emerging economies, on the whole, have not yet adopted comprehensive regulations, creating market opportunities for first or early movers. Adoption of a comprehensive regulatory framework can increase the availability of feedstock to recyclers by improving collection rates. Decisive regulatory action is a key driver in structuring and driving recycling activities that are not sufficiently profitable at present, by setting mandatory recycling targets or by supporting the establishment of financing schemes for e-waste collection and recycling. This will open the path towards domestic and/or foreign investment in capacity-building in the sector. Experience shows that successful regulatory regimes are self-reinforcing, with demand from recyclers for

raw materials (particularly precious metals) reinforcing incentives throughout the value chain.

However, while decisive regulatory action is a necessity, international case studies show that comprehensive and ongoing consultation and dialogue with industry and other partners is essential for success in implementation. For example, in India, dialogue among relevant stakeholders (producers, recyclers, collectors, NGOs, and government agencies) is helping the government to define India's e-waste strategy. In emerging economies, there is typically an 'informal sector' of e-waste collectors and processors that needs to be engaged and brought into the national strategy on e-waste.



Chapter 1

UNDERSTANDING E-WASTE

E-WASTE IS GENERATED BY A LARGE VARIETY OF APPLIANCES, FROM LARGE HOUSEHOLD APPLIANCES (WASHING MACHINES, REFRIGERATORS, ETC.) TO SMALL ELECTRONIC DEVICES LIKE CELL PHONES OR ANY CONSUMER ELECTRONICS. COLLECTION AND RECYCLING OF E-WASTE IS ONE OF THE MAJOR CHALLENGES IN THE WASTE BUSINESS DUE TO THE FACT THAT IT COVERS A WIDE RANGE OF END-OF-LIFE (EOL) PRODUCTS AND IS GROWING FASTER THAN ANY OTHER WASTE STREAM, DRIVEN BY A GROWING ELECTRONICS MARKET AND THE RISING OBSOLESCENCE RATE OF ELECTRONIC EQUIPMENT. THE THREE MAIN CATEGORIES OF E-WASTE GENERATORS ARE: PROCESS USERS (MANUFACTURERS), RETAIL USERS (HOUSEHOLDS AND SMALL BUSINESSES) AND BULK USERS (LARGE BUSINESSES, EDUCATIONAL INSTITUTIONS, GOVERNMENTS, ETC.).

E-waste is regarded as a critical environmental issue due to its content in toxic substances (cadmium, mercury, lead, CFCs etc.). Inappropriate end-of-life management of e-waste can generate important environmental and toxic impacts:

- Manual dismantling: persons dismantling electronic and electrical equipment manually are subject to health impacts.
- Landfilling: toxic substances present in e-waste can contaminate leachates and the ground soil.
- Incineration of e-waste (plastics containing BFRs mainly): incinerating e-waste (without appropriate dioxin abatement systems) will generate dioxins and furans.

E-waste is also a growing economic opportunity driven by:

- Valuable components and materials contained in electronic waste (gold, copper, other metals).
- New regulations and Extended Producer Responsibility (EPR) schemes that ensure additional financing for collection and recycling activities.

In developed countries, e-waste recycling began in the early 1990's, but was mostly limited to large household appliances that were recycled with end-of-life vehicles or other scrap metal (usually through shredding). Specialized e-waste recyclers progressively entered the market to offer services of proper environmental management of e-waste, in some cases anticipating upcoming legislation, or to increase value from recovery of materials contained in e-waste. The development of e-waste regulations (such as the EU Directive 2002/96/EC which sets mandatory targets for e-waste collection) increased the diversity of stakeholders in the e-waste recycling market.

Emerging economies have not on the whole adopted strong regulations on e-waste, although some developments have been summarized in this study. Future adoption of e-waste specific regulations will have considerable impact on the availability of feed-stock to recyclers by improving collection rates. Legislation will be a key driver in structuring and driving recycling activities that are not sufficiently profitable

Reverse logistics is “the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal. More precisely, reverse logistics is the process of moving goods from their typical final destination for the purpose of capturing value, or proper disposal. Remanufacturing and refurbishing activities also may be included in the definition of reverse logistics.”

— Hawks, Karen. VP Supply Chain Practice, Navesink.
Reverse Logistics Magazine Winter/Spring (2006).
<http://www.rlmagazine.com/edition01p12.php>

at present, by setting mandatory recycling targets or by supporting the establishment of financing schemes for e-waste collection and recycling. This will open the path for investment in the sector. Increasing pressure for access to raw materials (particularly precious metals) is likely to reinforce the existing incentives to set up specific regulations on e-waste.

Most e-waste generated worldwide is in North America, Europe, Japan, and China. According to UNEP sources, 20 to 50 million tons of electronic waste are generated each year. This figure is likely to increase with:

- The growing quantities of electronic devices and appliances sold each year; for example, one billion mobile phones were sold in 2006 and that number has doubled since.
- The rising obsolescence rate of electronic equipment. According to the US National Safety Council,

the average lifespan of a PC has shrunk from four or five years to only two years today.

The three main categories of e-waste generators are:

- Households and small businesses: ‘White goods’ such as washing machines and refrigerators form the largest part by weight of the waste arising from individual households, followed by TVs and PCs.
- Large businesses, educational institutions, governments: Office electronics—photocopiers, fax machines, printers, and in particular personal computers—form the large chunk of e-waste generated by this segment of users. Leasing agreements directly with the producers of EEE are common, and therefore they often do not directly dispose of their e-waste, instead preferring producers to take back their equipment at the end of the contract and replace them with upgrades.
- Original Equipment Manufacturers: Waste arising during the manufacturing process due to defective components or sub-optimal quality. Production wastes also occur along the upstream supply chain at every stage, which may be individual components, sub-assemblies or semi-finished products. Another source of e-waste from original equipment manufacturers is from product recovery and refurbishing operations.

In developed countries, e-waste recycling started in the early 1990’s, but was mostly limited to large household appliances that were recycled with end-of-life vehicles or other scrap metal (usually through shredding). Specialized e-waste recyclers progressively entered the market to offer services of proper environmental management of e-waste, in some cases anticipating upcoming legislation, or to increase value from recovery of materials contained in e-waste. The development of e-waste regulations (such as the EU Directive 2002/96/EC) around the world has triggered the emergence of an e-waste recycling market. Emerging economies, on the whole, have not yet adopted strong regulations on e-waste though some developments have been identified. However, Brazil and India have moved on national legislation on e-waste within the past two years.



All approaches to e-waste depend, to a greater or lesser extent, on the concept of ‘reverse logistics’—the need of manufacturers, distributors, and retailers to anticipate end-of-life and after-market issues of products sold.

An emerging environmental and sanitary issue

E-waste is regarded as an environmental and sanitary issue due to its content in toxic substances. These substances, their impacts, and sources are summarized below.

Inappropriate end-of-life management of e-waste can generate important environmental and toxic impacts:

- Manual dismantling: persons dismantling electronic and electrical equipment manually are subject to health impacts.
- Landfilling: toxic substances present in e-waste can contaminate leachates and ground soil.
- Incineration of e-waste (plastics containing BFRs mainly): incinerating e-waste (without appropriate dioxin abatement systems) will generate dioxins and furans.

Generic e-waste recycling cycle

The generic e-waste recycling cycle varies from country to country due to local specificities (maturity of the market, cost structure, technology available, etc.), but can basically be illustrated as follows:

1. Collection and transport

Consumers usually have control and ownership of e-waste at end-of-life and their commitment is crucial for high collection rates. Pick-up is convenient for the consumer and drop-off requires taking an obsolete product to a collection point. The accumulated e-waste is then transported to a treatment facility.

2. Sorting

E-waste is consolidated and prepared for processing and/or sorted to determine what equipment can be refurbished or reused as whole units and what equipment must be disassembled for commodity processing. Sorting can occur at collection sites where some “value screening” for reusable or re-saleable equipment is not uncommon. If not completely harvested there, reusable equipment or valuable components are separated by social enterprises and companies that focus on manual dismantling. These companies usually derive a considerable share of their revenues from either reuse of complete equipment or components with substantial value. Actual e-waste with non-significant reuse potential is sorted in order to prepare

Table 1. Potential hazards of e-waste

Substance	Impacts	Where it can be found
Lead	Potential damage to the central and peripheral nervous systems, blood systems, kidney and reproductive system in humans. Negative effect on children’s brain development.	TVs and monitors (especially CRT monitors); Small household appliances, IT equipment (circuit boards).
Cadmium	Toxic, with a possible risk of irreversible effects on human body.	TVs and monitors (CRT monitors); small household appliances, IT equipment (circuit boards).

(continued)

Table 1. Potential hazards of e-waste *(continued)*

Substance	Impacts	Where it can be found
Mercury	Damage to various organs, including the brain and kidneys, as well as the fetus.	Small household appliances, IT equipment (circuit boards, cell phones, etc.), fluorescent lamps including LCD backlights.
Hexavalent chromium/ chromium VI	Damage to DNA and extremely toxic in the environment.	Large household appliances (steel).
Plastics (including PVC)	Dioxins can be formed when PVC is burned within a certain temperature range.	Small household appliances, IT equipment (computers, cell phones, consumer electronics, etc.); TVs and monitors (CRT monitors), cables.
Brominated flame retardants (BFRs)	Impacts on neurobehavioral development.	Small household appliances, IT equipment (circuit boards); TVs and monitors (CRT monitors), plastics housings.
Barium	Short-term exposure to barium can cause brain swelling, muscle weakness, damage to the heart, liver, and spleen.	Small household appliances, IT equipment (computers); TVs and monitors (CRT monitors).
Beryllium	Classified as a human carcinogen as exposure to it can cause lung cancer.	Small household appliances, IT equipment (computers).
Toners	The black and color toners within the plastic printer cartridge may be carcinogen (esp. carbon black used).	Small household appliances (computer peripherals).
Phosphor and additives	Toxic to humans if touched.	TVs and monitors (CRT monitors).

it for material recycling and to maximize the material value recovery.

3. Cleanup & Dismantling

Dismantling is usually performed for:

- A sound recovery of hazardous components or substances. The removal of hazardous components is usually mandatory and specified by environmental authorities and a legal framework.
- The recovery of valuable components. Examples for valuable components are video cards, electric motors or PC components. Printed circuit boards

are often separated due to their high precious metal contents.

- The removal of unwanted parts. Sometimes, the presence of unwanted components substantially compromises the processing speed or the concentration of targeted metals in a fraction. Large plastic housings are a typical example.

Manual dismantling operations are still prevailing in industry practice, Western countries included. Fully or semi-automated dismantling is still a big challenge for the recycling industry, although several systems have been implemented as pilot

and testing facilities. Such facilities struggle with the wide variety of EEE designs that turns the application of standardized methods into a complicated venture.

4. Secondary processing

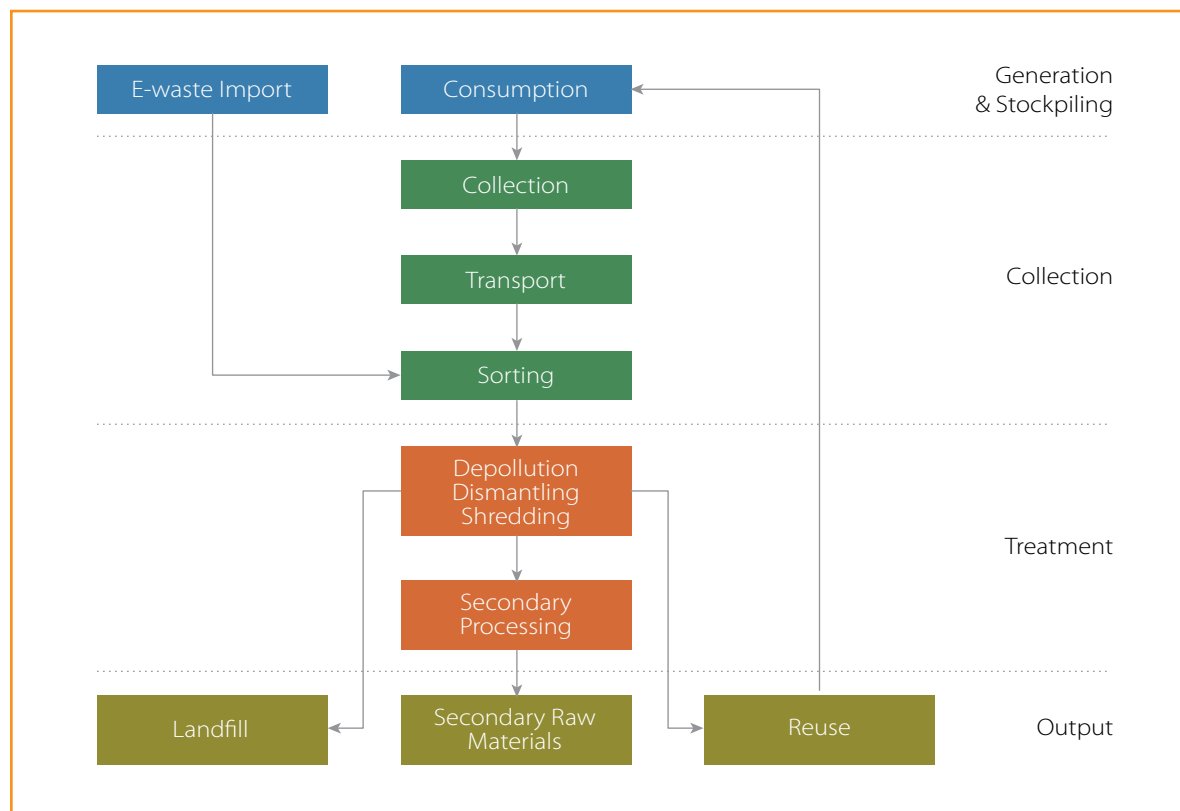
Secondary processing and reapplication options of materials after shredding and first separation are manifold. After electronic equipment is dismantled, it is processed into either feedstock for new production or refurbished into new equipment. Outputs from secondary processing activities include scrap commodities such as glass, plastics, and metals—the primary elements from which all electronic hardware is made. For export, and to a lesser extent national processing markets, there are significant issues associated with the environmental and health practices of current service providers in this part of the cycle.

5. Outputs

In an increasingly global electronics market, the basic composition of electrical and electronic devices is gradually harmonizing worldwide. Many valuable components and materials are contained in electronic waste (gold, copper, other metals).

In addition to material recovery, several parts and components from e-waste can be refurbished and reused or in some cases reused without refurbishment. These are mainly:

- Compressors from cooling and freezing appliances.
- Electric motors from vacuum cleaners and large household appliances.
- Erasable Programmable Read Only Memory (EPROM), Random Access Memory (RAM), integrated circuits (ICs), processors, hard drives, CD and DVD drives (and partly floppy disk drives), power supplies from computers or from other consumer electronics.





The different contents of e-waste after disassembly also require secondary processing to recover the different outputs:

- Ferrous metals account for about 50% of the total weight of e-waste; this mainly comes from large household appliances. As scrap metal is a critical input in all steel-making processes, demand for recycled steel is robust.
- Non-ferrous metals account for about 5% of the total weight of e-waste. The typical non-ferrous metals recovered from e-waste include aluminium, copper, tin, and precious metals. In the case of small household appliances, TVs, and monitors, non-ferrous metals are found in particular on printed circuit boards (PCBs). After the disassembly of the circuit board, metals are smelted so as to recover lead, copper, platinum, palladium, and other precious metals.
- Glass from CRTs can be utilized in several ways: direct glass-to-glass recycling, replacement for feldspar in the ceramic industry or as replacement for sand in the building industry.
- Plastics can be incinerated with energy recovery, recycled or used in gasification plants. Recycling

requires the separation of plastics containing brominated flame retardants and several sorting operations to separate plastic resins.

- Hazardous materials that are separated in the cleanup stage are recycled, incinerated, or disposed of in special landfills. For example, batteries are recycled, mercury is recovered, CFCs and asbestos are incinerated, and PCB suspect capacitors are disposed of in special landfills.

E-waste regulatory and organizational models

Regulatory rules determine the basis on which the market is organized. The object of regulatory frameworks is frequently to mitigate health and environmental risks from toxic substances in e-waste, though in China it is driven by the need to reduce pressure on primary commodities in a world with dwindling resources.

Regulation of e-waste management is key to the whole process as it has historically been the main catalyst of an organized e-waste collection and recycling market. The absence of regulation hinders the

emergence of a formal e-waste market because it is not a profitable activity in this situation: collection and treatment costs—with proper health, security and environmental management—are not offset by potential revenue from reuse or material recovery.

Globally, there are essentially three regulatory models for e-waste; Extended Producer Responsibility (EPR), Consumer Pays, and a Mixed Model. These models are summarized in the table immediately below.

Table 2. Summary of three main regulatory models

	Europe EPR	United States Mixed	Japan Consumer Pays
General principles	<p>EU-Directive 2002/96/EC and national transpositions based on the principle of Extended Producer Responsibility (EPR) → producers and importers of electrical and electronic equipment are responsible for their products over the whole life cycle.</p> <p>Key aims of the E-Waste Directive are to:</p> <ul style="list-style-type: none"> • Reduce e-waste disposal to landfill. • Improve product design. • Achieve targets for recovery, reuse and recycling. • Establishment of collection facilities and separate collection systems. • Implementation and financing by producers of systems for the recovery and treatment of e-waste. <p>The directive sets targets for reuse/recycling and recovery depending on product category (from 50% to 80%) and the E-Waste Directive sets a collection target of 4 kg per year per inhabitant for the member states as well.</p>	<p>In the US, the term e-waste is used for end-of-life products belonging to the categories of information and communication technology and consumer electronics. There is no existing federal regulation and the National Electronics Product Stewardship Initiative (NEPSI) failed to reach consensus, mainly on the issue of financing. This has led to a patchwork of state regulations, mostly based on EPR principles.</p>	<p>The Home Appliance Recycling Law, fully enforceable as of 2001, requires manufacturers or importers to recycle four types of household e-waste:</p> <ul style="list-style-type: none"> • Televisions (CRTs, LCD/PDP TVs), • refrigerators and freezers, • washing machines, • air conditioners. <p>The recycling program was extended to business PCs from April 2001 and residential PCs from October 2003. Recycling obligation rates according to re-commercialization standards are:</p> <ul style="list-style-type: none"> • air-conditioners: 70% • television sets (CRT-based): 55% • television sets (liquid-crystal or plasma): 50% • refrigerators: 50% • washing machine/drying machines: 65%

(continued)

Table 2. Summary of three main regulatory models *(continued)*

	Europe EPR	United States Mixed	Japan Consumer Pays
Organiza- tion and financing	<p>Producers are responsible for the costs of picking up waste electrical and electronic equipment from collection facilities, and refurbishing waste products for reuse or for recycling and recovery.</p> <p>For “historical” products, costs of waste management are to be shared by all producers.</p> <p>For new products, producers have “individual responsibility” and pay the cost of managing their own products. They can do this through programs set up by individual companies or through participation in collective schemes.</p> <p>Producers may show a separate “visible fee” for eight years (ten years for large household appliances) on new products.</p> <p>Two alternative national implementation models have been developed in Europe:</p> <p><i>Monopolistic national collective system:</i> simplest way forward, economies of scale guaranteed, encourages high collection rate, but does not provide strong incentives for cost reduction).</p> <p><i>Competitive clearinghouse system</i> with a public registration, allocation, reporting and monitoring system: compliance at least cost, but risk of high transaction costs and consumer confusion.</p>	<p>Three examples of organizations:</p> <ul style="list-style-type: none"> • Maine: limited producer responsibility as municipalities are in charge of collection and consolidation and manufacturers pay to ship and recycle consolidated e-waste; no recycling goals, but measures in place to treat orphan waste; manufacturers billed for collection based on return share. • Minnesota: full EPR as producers have to register with the state, pay a registration fee based on market share and have to set up an e-waste recycling program and are required to meet specific recycling targets; they can, however, get credits for exceeding those targets. • Oregon: full EPR as producers must register to participate in recycling programs and provide collection sites for e-waste; state offers possibility to join a “state contractor plan” for a fee. 	<ul style="list-style-type: none"> • Retailers are the primary actors responsible for collecting end-of-life products. • Municipalities and designated corporations (Association for Electric Home Appliances, AEHA) are responsible for the collection of the remaining products. <p>It is the end users (consumers) who pay for the collection at the time of disposal (end-user-pays). The fee is set by those physically responsible for collection. The majority of the fees per item set by the retailers have been between ¥1,700 and ¥6,000 (€16 to €56).</p>

Table 2. Summary of three main regulatory models *(continued)*

	Europe EPR	United States Mixed	Japan Consumer Pays
Strengths and weaknesses	<ul style="list-style-type: none"> • Achievable progressive targets that encourage high and growing collection rates. • Cost borne by producer encourages upstream measures to reduce downstream compliance costs (eco-conception). • Range of compliance options appreciated by producers, which encourages support. • Discrepancies among member state regulations leads to heavy administrative burden for producers. • Distribution of responsibility (member states) is a hindrance to enforcement. 	<ul style="list-style-type: none"> • EPA works with all stakeholders to reduce the environmental impacts of electronic products during the life cycle. • Variety of models brings a variety of lessons for a future national model. • Patchwork of regulations is a hindrance to the emergence of national champions. • Strong border issues as transfers cannot be regulated by states in the absence of a federal compliance regime. • No national awareness of e-waste issues. 	<ul style="list-style-type: none"> • Strong and achievable targets, including focus on most hazardous wastes (CFCs). • Up-front payment by user ensures sound finances • Weak eco-conception incentives. • Weak monitoring and frequent violation of compliance by retailers. • Incentive for illegal dumping instead of paying the collection fee.



Chapter 2

SECTOR-MAPPING: BRAZIL

The electro-electronic manufacturing sector

Brazil's electronic/electrical manufacturing sector largely focuses on the domestic market. It is organized into two national associations: professional—ABINEE—and durable consumer products—ELETROS. Computer manufacturing comes under the relevant IT professional association. Some product niches are not well met by domestic manufacturing, and are imported. While good production and export data are available, there is not yet reliable forecast data to allow studies for e-waste. This has led the two associations above to contract a specific study, being undertaken by GIA, the Global Intelligence Alliance,

on e-waste volume projections in a time frame of approximately five years.

Growth in electronic/electrical products

The electronic/electrical industry in Brazil is large and growing. It currently contributes 3.5% of GNP. ABINEE's membership represents more than 90% of the total professional electronic/electrical industry. These companies had an average growth of 11% in 2010 with total revenues of US\$72.96 billion. They are expected to grow another 13% in 2011.

Brazil's currency valuation, compared with the US dollar, reduces the competitiveness of local manufacturing, especially in electronic/electrical products, contributing to the growth of imports in this sector.

Table 3. Industrial associations and their main segments

Professional electro-electronic products	Durable electronic/electrical consumer products
Industrial automation	Refrigerators
Electro-electronic components	Stoves and ovens
Telecommunications	TV sets, recorders, DVD players
Energy (generation, transmission, and distribution, GTD)	Radio (including radios for cars)
Industrial equipment	Washing machines (including dish washing)
Information technology	Freezers
Electrical material for construction	Photographic cameras
Domestic utilities	

Sources: Abinee (www.abinee.org.br) Eletros (www.eletros.org.br) Suframa (www.suframa.gov.br)

Local production is mostly destined for the domestic market, with only 4% of product exported on average. Table 4 below shows the industry revenues and growth rate for the professional segment.

ABINEE publishes manufacturing data on mobile phones and personal computers (PCs), as shown in Table 5:

Mobile. The total number of mobile phones in use in Brazil has reached 202.9 million, while the total population in the country, from the 2010 census, is 190,732,694 persons (www.ibge.gov.br), giving a penetration rate of 104%.

Domestic production of mobile phones averages a failure rate of rejected pieces of around 2%. Mobile export from Brazil, mainly to neighboring countries, varies from 20 to 29% of total production, depending on the value of the US dollar. With less affluent customers increasingly entering the market, the number of prod-

ucts targeted to this market segment grew in 2010. At the same time, new models and services attract more affluent customers to change their phones more often, and this segment tends to own more than one mobile per person.

The gray market in mobile phones is composed of imported products being sold without prior approval of ANATEL—the Government Telecommunication Agency—www.anatel.gov.br. The gray market comprises about 20% of mobiles in use and represents a challenge for e-waste policy, particularly given producer liability approaches to e-waste.

Overall, the mobile picture is of strong and continued growth and obsolescence contributing significantly to e-waste in Brazil.

PCs. For over a decade, government policies have promoted local offers of PCs and computers in schools and public organizations. These policies, together

Table 4. Growth and revenues by segment (R\$ and US\$ billion)

Professional electro-electronic products	2009 R\$	2009 US\$	2010 R\$	2010 US\$	2010/2009
Industrial automation	2.943	1.731	3.152	1.854	+7%
E-e components	8.263	4.861	9.350	5.500	+ 13%
Industrial equipment	15.000	8.823	18.311	10.771	+ 22%
Energy - GTD (generation-transmission-distribution)	10.604	6.238	12.101	7.118	+ 14%
Information technology	35.278	20.752	39.917	23.481	+ 13%
Electrical material for installation (wires & cables)	7.954	4.679	8.912	5.242	+12%
Telecommunication	18.367	10.804	16.714	9.832	– 9%
Domestic utilities	13.427	7.895	15.583	9.166	+ 16%
Total	111.839	65.783	124.040	72.964	+ 11%

Source: ABINEE - (currency US\$ = 1.7R\$)

Table 5. Mobile phones and PC units

Product	2009 (units)	2010 (units)
Personal computers (PCs)	12 million	14 million
Mobile phones	62 million	61 million*

Source: Abinee & Teleco (www.teleco.com.br) *estimated

with the growth of Internet services, the spread of e-government services in all levels of government, and the growth of e-commerce, have driven an expansion of local production and the reduction of the gray market. Previously, unbranded and home-assembled PCs had accounted for 30 to 35% of the domestic PC market, but this is quickly decreasing.

Domestic PC manufacturing has shown constant growth in the past ten years, with several gray market companies closing and many joint ventures launched between large and small companies, indicating a relatively mature industry. However, consumers are very price sensitive and imports are affected by variations in the value of Brazilian currency, making it possible that the grey market may again flourish.

Other items such as batteries & solar cells and Radio Base Stations (RBS) are considered as e-waste, due to the volume in use and their wide distribution:

Batteries. Battery collection by the public, with final responsibility resting with the producer, has been in place since 1999. Brazil manufactures about 1.2 billion batteries per year, including batteries for automotive, telecommunication, energy, and consumer use. Battery production is increasing. For example, in 2010, one producer of motorcycle batteries increased production by 1.5 million to 3.8 million batteries per year.

RBSs. There are 49,853 RBSs installed in 5,544 municipalities (98% of municipalities in the country) to provide connectivity for mobile phones. The constant growth of demand for mobile connectivity and mobile operators' contracts for signal cover with the Telecommunication Agency will increase the numbers of RBS. Due to Brazil's vast geography, many RBSs are vulnerable to theft or scavenging for e-waste.

Electronic/electrical durable consumer products

The manufacture and sale of white and brown goods (e.g. fridges and cookers) at affordable prices is steadily increasing in Brazil, leading to an increase in e-waste. ELETROS (www.eletros.org.br), the association of manufacturers of durable consumer products, showed 2010 revenue for domestic manufacturers of US\$11.33 billion, a growth of 46.69% from 2009. The average growth in 2010 of Brazilian white goods

in 2010 was 7%, and 10% for portables, while brown goods growth was 15%.

Some of the 2010 growth of LCD TV sales in 2010 is attributed to the FIFA World Cup in South Africa. Regular tube TV production has declined by 30%; the consequence of this consumer preference will certainly drive e-waste volume as consumers replace tube televisions with LCD sets in the coming years. Table 6 below, showing penetration of TV sets from 2006, gives an indication of the growth that can be expected.

Statistics from the IBGE give further detail on increasing penetration rates of durable electrical/electronic products in Brazilian homes.

Interestingly, the figures above show that television is a hugely important product for Brazilians. Although a television is more expensive than a refrigerator, which is also much needed in a tropical climate, more people prefer to spend their limited disposable income on a TV set. Another national behavioral quirk of relevance to e-waste is that, typically, the more affluent tend to give old appliances to domestic servants rather than send the machines for recycling. Many electronic/electrical products will pass through more than two hands before they are ready to be discharged, ultimately ending their useful lives in the hands of the less affluent, who typically have less information and concern about environmental issues.

Other products and associations

Other product volumes are growing, including medical electronics and automotive electronics.

Medical electronics. The Brazilian Association of Medical Devices Manufacturers—ABIMO—has 320 member companies, representing 66% of the sector and 80% of revenues. These companies are concentrated in the southeast and south region of the country, with 40% in São Paulo. This sector exports 8.8% of its output and the total annual revenues are US\$4.5 billion.

Automotive electronics. The automotive sector, with more and more electronics in its products and the supply chain industry around it, accounts for 5.4% of GNP, and is a major user and producer of electro-electronic parts. Brazil is also the world's largest urban bus producer and the largest truck producer in Latin

America. In 2010, the industry sold 3,638,390 units and exported 14.8% of production. The sector has grown by 14.3% from 2009 to 2010.

Commerce. 23,598 stores with more than 5 employees sell electronic/electrical products in Brazil. São Paulo state has 20% of these stores and the segment has grown from 2000 to 2009 at a rate of 9.2% a year. In 2010, due to the FIFA World Cup, the segment grew by 18.9% and is expected to grow by a further 10% in 2011.²

Import of electronic/electrical products

Despite its considerable domestic manufacturing base for white and brown goods, Brazil imports significant amounts of electronic/electrical components or specialist equipment. Brazil particularly lacks electronic component producers. Imports of electronic components amount to 53% of the total of electronic/electrical imports, reaching US\$17 billion in 2010.

Table 6. Industry Pole of Manaus (PIM): electro-electronic industry production

Main products	Jan-Nov 2010 Units in millions	Growth 2010/2009
LCD TV sets	7.712	121.86 %
Traditional tube TV sets	3.410	– 30%
Radios & recorders, audio products (not portables)	1.084	97.17 %
Watches (wrists & pocket)	8.261	52.82 %
LCD monitors (IT use)	1.524	47.02 %
Digital cameras	2.957	41.51 %
Plasma TV sets	0.401	39.63 %
TV (signal) receivers	6.807	24.02 %
Home theaters	0.612	22.77 %
Telephone sets (intercom sets in general)	0.343	22.75 %
Microwave ovens	3.449	19.21 %
Car radios and other portable audio sets	2.042	13.97 %

Source: Suframa (www.suframa.gov.br)

Table 7. Electrical/electronic products in Brazilian homes

Products	2006 in millions		2007 in millions		2008 in millions		2009 in millions	
Stove/ovens	53,348	99.9%	55,282	99.90%	56,541	98.20%	57,638	98.40%
TV sets	50,800	95.2%	53,218	96.20%	54,753	95.10%	56,043	95.70%
Refrigerators	48,711	91.00%	51,158	92.40%	52,989	92.10%	54,716	93.40%
Radio	47,987	89.90%	49,641	89.70%	51,173	88.90%	51,466	87.90%
Washing machines	20,942	39.30%	22,259	40.20%	23,899	41.50%	25,968	44.30%
Freezers	8,980	16.00%	9,188	16.60%	9,236	16.00%	8,919	15.20%

Source: IBGE PNAD (www.ibge.gov.br)

Table 8. Other electronic/electrical products

Industrial consolidated segment	2010 Growth
Office and informatics products	13%
Electrical machines, materials and other products	8.8%
Electronic equipment, material, and other telecommunication products	3%
Medical and hospital instrumentation and equipment, including electrical, electronic and optical	20,7%

Source: MDIC-SDP (www.desenvolvimento.gov.br)

Table 9. Electronic component imports, 2009-2010

Products	2009 US\$ million	2010 US\$ million	Growth 2010/2009
Telecom components	2,239	4,265	86%
Semiconductors	3,024	4,180	38%
Informatics components	2,484	3,156	27%
Measurement instruments	978	1,177	20%
Avionics and car electronics	902	1,169	30%
Motor-generator group	494	912	84%
Industrial equipment	603	793	31%
Electro-medical equipment	527	727	38%
Data processing machines	418	671	61%
Passive components	393	562	43%

Source: Abinee (www.abinee.org.br)

According to BNDES, the Development Bank of Brazil (www.bndes.gov.br) 45% of medical equipment is imported.

Finally, several additional factors or events will drive Brazilian electronic/electrical demand in the coming decade:

The discovery of huge deep-sea oil off the south-east coast of Brazil will attract investments forecast at US\$200 billion between 2010 and 2012, with 20 to 30% spent on telecommunications, IT and energy.

The FIFA World Cup of 2014, to be held in Brazil, and the 2016 Olympic Games in Rio de Janeiro will make great demands on energy, IT and telecoms, and require significant expenditure on equipment.

The PNBL—National Broadband Plan—aims to offer broadband connection to 72% of homes in 2014. Although the goal is ambitious and may not be fully met, it will nonetheless drive demand for information and communications technologies (ICT) equipment.



Chapter 3

POLICY AND LEGISLATION MAPPING: BRAZIL

BRAZIL'S 1988 CONSTITUTION GUARANTEES, IN ARTICLE 225, THAT EVERY CITIZEN HAS THE RIGHT TO LIVE IN AN ECOLOGICALLY BALANCED ENVIRONMENT, AND THAT THE ENVIRONMENT IS A COMMON GOOD TO BE PRESERVED FOR FUTURE GENERATIONS. WHEN THE CONSTITUTION WAS APPROVED, SEVERAL LAWS REGARDING THE ENVIRONMENT WERE PROMULGATED BY ALL THREE LEVELS OF GOVERNMENT IN THE COUNTRY.

Brazil has two major areas of electronic/electrical manufacturing: the Southeast Region, which comprise the producer states of São Paulo, Rio de Janeiro and Minas Gerais, and the Polo Industrial de Manaus (PIM), capital of Amazon State in the North Region. There are also some electronic/electrical manufacturing companies in the southern region comprising the states of Parana, Santa Catarina and Rio Grande do Sul. Also, in the northeast Bahia is a center of electronic/electrical manufacture. Although electronic/electrical retail and trading is distributed around the country, the major retailers have their headquarters in these states.

A list of environmental legislation of all states in the country has been prepared and will be published separately.

Federal laws, decrees and other rules

The Law 12305/10 is an overall legal framework on solid waste, and it attributes shared responsibilities

throughout the value chain in the product life cycle. The law requires producers, trade, users (consumers) and waste actors of selected product segments to appropriately collect and treat waste material of products. The law follows international approaches in implementing the concept of reverse logistical responsibility, which imposes responsibility for e-waste throughout the whole producer chain (manufacturing companies, distributors, importers and retailers) and demands that those responsible organize points of collection for e-waste. Its Decree 7404 from December 23, 2010 defines the shared responsibility of all involved, including consumers and municipal authorities.

Decree 7404 also creates an interministerial committee with members from the following ministries: Environment (Coordinator)/Home Affairs/Cities/Mines & Energy/Treasury/Health/Social Development & Fight Against Famish/Planning, Budget & Administration/Development Industry & Trade/Agriculture, Livestock & Provisioning/Science & Technology and the Secretariat of Institutional Relations. The committee is required to:

- Define all procedures required under the National Plan of Solid Waste—the agreement with all segments of industry and trades—evaluating its implementation and suggesting various implementation measurements for the National Policy for Solid Waste. (Art. 15 of Law 12305, 2010).
- Define additional information for the plan for management of hazardous solid waste (Art. 39 of Law 12305, 2010).
- Promote studies and subsequent activities to reduce taxes on reused and/or recycled products, and simplify proceedings needed for the circulation of products and packaging using such materials.
- Define, using research studies, the necessary conditions for the creation or modification of financing facilities in the federal finance institutions.
- Define strategy to promote and spread knowledge and the use of clean technologies for the management of solid waste.
- Promote research & development for recycling, reuse and treatment of solid waste.
- Define and evaluate the implementation of specific mechanisms to promote decontamination of orphan areas as stated by Art. 41 of Law 12305, 2012.
- Implement actions to ensure the implementation, execution, and revision of the plans for solid waste referred to by Art. 14 of Law 12305, 2010.
- Define and contract specific studies to establish demand mechanisms and management of solid waste.

Most notably, implementation of the federal framework on solid waste is to be largely achieved via agreements between each sector and the government. The electrical/electronic manufacturing sector is one of the defined sectors, and is the particular focus of this report.

Implementation instruments are as follows:

- Sector agreement
- Rules published by the federal government
- Terms of commitment

The Decree defines only the framework related to the agreement, leaving it to the sector to define how

they will implement it. The sector agreements must contain at least the following elements:

- Indication of products and packaging, i.e. the objects of the sector agreement.
- Description of the stages of product life cycle for reverse logistics system, as set forth in paragraph IV of Art. 3 of Law 12305, 2010.
- Description of how the deployment of reverse logistics will work.
- Whether contracting entities, cooperatives or other forms of association of collectors of recyclable or reusable materials can be used for implementation.
- The involvement of government agencies in proposed actions, when they are responsible for part of the logistics to be deployed.
- Definition of forms of consumer participation.
- Mechanisms for dissemination of information on existing methods on recycling and disposal of solid waste, including products and packaging.
- Goals to be achieved within the reverse logistics system to be deployed.
- The goals may be established based on quantitative, qualitative or regional criteria.
- Timeline for deployment of reverse logistics, including interim steps to be developed until the ultimate goal is achieved.
- Information about the possibility and feasibility of using the waste generated, including warnings of dangers posed by their handling.
- Identification of hazardous waste at different points along the value chain, and procedures to minimize or eliminate its risks and impacts to human health and the environment.
- Evaluation of social and economic impacts of the implementation of reverse logistics.
- Description of assignments, individual and joint, for all participants of the reverse logistics system in the process of collection, storage, transportation of waste and dealing with packaging. This focuses on reuse, recycling or environmentally sound final disposal, and shall contain the reverse flow of waste, distinguishing the various steps of reverse logistics and the final disposal of waste generated, as well as used or post-consumer packaging and, when

appropriate, the remains of the product, which should include:

- ♦ Technical recommendations to be observed at every stage of the chain, including consumers and recyclers.
 - ♦ Ways of collection or delivery, identifying those responsible and their responsibilities.
 - ♦ Necessary actions and criteria for implementation, operation and assignment of responsibilities for the collection points.
 - ♦ Transport operations between enterprises or other participants, identifying responsibilities.
 - ♦ Procedures and identification of those responsible for reuse, recycling and treatment, including waste screening, and for environmentally sound disposal of waste.
- Clauses providing for penalties applicable in case of default of obligations under the Agreement.

Finally, it is relevant to state that Brazil's target date to eliminate all open landfill deposits is 2014.

The implementation of the sector agreement between the government and the electrical/electronic sector, has been under direct discussion since early 2011, and is expected to be finalized in the first half of 2012.

State-level initiatives

Brazil has 26 states and 1 Federal District where its capital, Brasilia, is located. This section focuses on the analysis of state legislation in electronic/electrical manufacturer states mentioned above.

Amazonas State has a peculiar characteristic due to the existence of a free Zone of Manaus, its capital. Manaus concentrates more than 90% of the economy of the state, as the Amazon forest and its rivers occupy most of the territory.

São Paulo

The entire environmental legislation of São Paulo State is available at <http://www.ambiente.sp.gov.br/contAmbientaLegislacaoAmbiental.php>. The Regu-

latory Act 131 was repealed on March 31, 2011 due to the difficulties the industry had in meeting its requirements under new federal legislation. The state published one of the first laws related to e-waste, the Technological Waste Law, No. 13576 of July 6, 2009, which establishes standards and procedures for recycling, disposal and management of e-waste. The law follows the reverse logistics principle and states that the electronic/electrical products and components must be disposed of at an adequate final destination, to avoid damage to the environment and society. The final destination of the product/component is the shared responsibility of the companies that produce, market or import them. Additionally, it is the responsibility of the company that manufactures, imports or sells consumer electro-electronics to accept the e-waste discarded by the consumer.

The legislation allows for the following destinations:

- Recycling and use of the product or its components for the original or a new purpose.
- Partial or total reuse of products and components.
- Neutralization and appropriate disposal of e-waste when treated as chemical waste.

The law also states that the final destination of e-waste be equal to that of chemical waste in terms of environmental legislation and standards of public health and safety, regarding the prohibitions and restrictions established by public authorities. This also applies for e-waste that contains heavy metals or toxic substances, for which disposal will be done with environmental licenses issued by the Secretariat of the Environment, which may require environmental impact studies.

Any electronic/electrical products and components sold must display the following information to the consumer on their packaging or labeling:

- Warning not to be discarded in regular trash.
- Guidance on collection point for e-waste.
- Address and contact telephone numbers of those responsible for disposal of material to final disposition.
- Warning about any heavy metals or toxic substances.



São Paulo state is committed to developing environmentally conscious behavior in its population. Fees and penalties collected will be directed to waste collection programs and related public activities. Since much of the Brazilian electrical/electronic market is concentrated in this state, the prior existence of the state law will help implementation of the federal law. It will encourage the electric-electronic industry to establish priority goals at the state level, and to develop best practices on wider implementation.

Rio de Janeiro

Rio de Janeiro, one of the southeast states, has no recent law specifically on either solid waste or e-waste. The most recent law on solid waste is Law 4,191 of September 30, 2003, but it does not adopt the reverse logistics model. The state-level Law 40,645 of March 8, 2007, requires the separation and recycling of solid waste generated by the public sector. There is no specific legal act related to e-waste.

The only e-waste initiatives are driven by software companies. The local software association (www.riosoft.com.br) runs programs called *Reciclação* and *Assespro Rio* (www.assespro-rj.org.br) to promote awareness about e-waste and collect, rebuild and

donate used computers, printers and other e-waste. The projects are recent, so at present it is difficult to measure their results.

Minas Gerais

Minas Gerais was one of the first states to deal with e-waste. The state developed a project in partnership with the Swiss State Secretariat for Economic Affairs (SECO). Also, the State Environmental Foundation in Minas Gerais (Fundação Estadual de Meio Ambiente, FEAM) carried out a study in 2008-2009. Recently, the state published the Normative 162 of December 27, 2010 through the COPAM (State Committee for Environmental Policy) to prepare an inventory of solid waste in the state in 2009, by February 25, 2011. However, this inventory focuses only on sanitary landfills. While such landfills are improving, they are not an adequate solution for the e-waste issue. The state also has a site to register entities responsible for generating waste: sisemanet.meioambiente.mg.gov.br.

The legislation for solid waste, Law 18032 of January 12, 2009 defines the concepts the law uses or introduces, providing a solid framework for further actions. The following principles form the basis of the law:



Photo Credit: Arthur Fellig

- Waste generation, prevention, and reduction
- Waste reuse
- Waste recycling
- Waste treatment
- Environmentally sound final destination for waste
- Solid waste valuation

Minas Gerais does not yet have a specific law on e-waste, but Bill 2131 of 2008, based on reverse logistics principles, imposes responsibility throughout the whole producer chain. The bill also proposes that the packaging of any product sold or developed in Minas Gerais include disposal information and warnings.

Parana

Parana's border with Paraguay is a significant entrance point for illegal products, including mobile phones. Paraná has enacted a law for solid waste, Law 1249322 of January 1999, which sets out the principles, procedures, rules and criteria related to the generation, packaging, storage, collection, transport, treatment and final destination of solid waste in the state. The law focuses on pollution control and minimization of environmental impacts and deals with a

wide variety of solid waste and how to deal with it, including by landfill.

The law also focuses on the entire product life cycle, stating in Article 3 that waste generation is to be reduced, and adopting processes to generate less waste and reuse or recycle more of it, prioritizing recycling over other alternatives of disposal.

The Parana law also applies the concept of reverse logistics, applying responsibility back through the production chain. Article 4 states that any activity generating solid waste is responsible for its packaging, storing, collection, transportation, final disposal and for the environmental results of such waste, as well as responsibility for environmental degradation.

The municipality of Curitiba, the state's capital, enacted its Municipal Law 13509 of June 8, 2010, implementing a similar approach to the state law.

Santa Catarina

The state of Santa Catarina houses significant industry, predominantly in the mechanical and weaving sectors, but is also home to electronic/electrical companies. The only law related to solid waste, Law 15112 of January 19, 2010, prohibits the disposal of solid waste, recyclables or reusables in open land-

fills or even sanitary landfills. The law also defines penalties and fines to be allocated for environmental protection and recovery.

Rio Grande do Sul

Rio Grande do Sul pursues various ecological activities of social relevance and public interest; in addition, it has enacted several laws on solid waste, such as Law 9493/92 on selective waste collection including e-waste materials. Law 9921/93 provides for the management of solid waste, under the terms of the State Constitution, Article 247, Paragraph 3, and related issues. The law's regulation came into effect in 1998, by State Decree 38356 of April 1, 1998. In 1997, another law provided for the final destination of rechargeable and non-rechargeable batteries, fluorescent lamps, and other products containing heavy metals—Law 11019 of September 23, 1997.

This legislation employs the reverse logistics model in Article 8, which makes the collection, transportation, processing, and final destination of any solid waste the responsibility of the entity that generated it. If there is shared responsibility, the law requires the third party to obtain licenses issued by the state agency, FEPAM. Law 11019/97 above defines specific treatment for each category of e-waste (e.g. batteries and fluorescent lamps), defining reverse logistics and shared responsibility for them, and expanding responsibility to the consumer who must return used products to the retail point of purchase. Law 13306/09 introduced an obligation for retailers, requiring them to provide adequate places for the return of e-waste by consumers.

Bahia

Bahia does not have laws regulating solid waste. The state government chose first to create a program to regionalize the management of solid waste. The 2007 program was created by the state's Secretariat for Urban Development and the Ministry of Environment's Secretariat of Water Resources and Urban Environment. The study defined a plan, adopted in 2010, that divided the state into 26 regional units and assigned collection points, taking into consideration the quality and existence of roads and the population concentration of Bahia.

Pernambuco

Pernambuco enacted a new policy on solid waste, Law 14236, on December 14, 2010. It is a revision of a prior law on solid waste, Law 12008/2001 and its Decree 23941/2002, and takes a new approach, based on the social-environmental state tax (ICMS) criteria for solid waste.

The law also includes the following plans:

- The State Program for Solid Waste Management (PEGRS), which provides benchmarks and rules defining responsibilities, institutional proceedings, etc.
- The Integrated Management Plan for Solid Waste (PGIRS) to be implemented by law in each municipality in the state.
- The State Information System for Solid Waste (SEIRES), which is part of the National System for Sanitary Information (SNIS) and will be a database for the above programs.
- An Inventory for the Solid Waste in the State, in accordance with the rules from CONAMA (National Committee for the Environment), which demands that firms generating solid waste present information about its generation, characteristics, and final destination.

The state law, the Federal Law 12305/2010, and its decree are harmonized, defining the reverse logistics and shared responsibility for the collection, transportation, treatment and disposal of solid waste. The law also addresses issues related to sanitary landfills.

Ceará

Ceará is developing a bill on e-waste—Bill 426/07—in the state's Legislative Assembly. In 1993, the state approved Law 12225 of December 6, 1993 on selective collection and recycling of waste, considering such activities as ecologically relevant and in the public interest. Law 12994 of September 27, 1999 provides for the discharge of small batteries up to 9V, mobile batteries, and other products containing heavy metals. Finally, in 2001, Law 13103/2001 created a state policy on solid waste. The 2001 law was relevant for the time, but is incompatible with federal law regarding the reverse logistics principle and shared responsibilities.

However, it is a good platform of definitions, principles, objectives, incentives and plans for municipalities and private sector participation.

Relevant municipalities

According to IBGE (www.ibge.gov.br), in 2008 six municipalities generated 25% of Brazil's GNP: São Paulo (São Paulo), Rio de Janeiro (Rio de Janeiro), Brasília (DF), Curitiba (Parana), Belo Horizonte (Minas Gerais) and Manaus (Amazonas).

The individual contributions to Brazilian GNP are:

- São Paulo: 11.8%
- Rio: 5.1%
- Brasília: 3.9%
- Curitiba: 1.4%
- Belo Horizonte: 1.4%
- Manaus: 1.3%

For the purposes of this report, the states with the most significant electronic/electrical manufacturing capacity, and consequent e-waste and relevant laws, are São Paulo and Manaus.

São Paulo city

The metropolitan area of São Paulo city enacted its first legislation on solid waste and related issues, Law 13478, on December 30, 2002.

The law was based on the concept of reverse logistics, imposing responsibility on the producer. The Law also defines the role of each entity involved in the waste chain and their individual responsibility, and each agent's responsibility for any damage caused to the environment or public health. Other laws and decrees followed this first law, adding clauses or changing them, as did Law 13316/2002, regulated by its Decree 49532/2008, and Ordinance SVMA97/2008, which

required recycling or buy-back of packaging of products developed or sold in the city. In October 2010, the Municipality of São Paulo's Legislative House consolidated seven bills then before the House into a more up-to-date alternative that was harmonized with state and federal laws.

Manaus

Manaus is the only industrial area in Amazonas state, and any industrial legislation produced by the state focuses on Manaus. The only legislation relevant to solid waste is the Directive Plan for Solid Waste—PDRS (Plano Diretor de Resíduos Sólidos)—of October 2010. The PDRS sets out the approach to solid waste and the need to review local legislation, in Law 1411 of 2010. The PDRS foresees:

- A macro-level plan for solid waste services.
- Collection of solid waste from residences, small businesses, and small-scale construction & demolition sites.
- Management of large-scale construction and demolition with producers of solid waste from large businesses, concentrating on the 'Industrial Pole of Manaus' (PIM).
- Fees and penalties.
- Access to municipal and state funds for Manaus' infrastructure.
- Fiscal incentives, such as reduction of the municipal tax (ISS) and urban land use tax (IPTU).
- The PDRS also anticipates an agreement between government, business and the association of waste collectors, defining rights and responsibilities for each, as well as efficiency goals focusing on development of the collectors.

It will require significant efforts to align these initiatives with the federal law.



Chapter 4

BUSINESS MODEL ANALYSIS: BRAZIL

AS DESCRIBED ABOVE, BRAZIL HAS A SOLID FEDERAL LEGAL FRAMEWORK THAT STATES CAN MIRROR IN THEIR OWN LEGISLATION. SOME STATES ALSO HAVE EXISTING LEGISLATION APPLYING THE SAME CONCEPTS AS THE NEW LAW. MOREOVER, SEVERAL COMPANIES HAD ALREADY BEGUN THEIR REVERSE LOGISTICS AND/OR SHARED RESPONSIBILITY ACTIVITIES. THIS SECTION CONSIDERS SEVERAL BUSINESS MODELS FOR E-WASTE PROCESSING CURRENTLY IN USE.

Small and micro enterprises

According to SEBRAE, Brazil has 5.9 million small to medium enterprises (SMEs) as of February 2011. To allow SMEs, including microenterprises, to operate legally, the federal government introduced in 2006 the general law on SMEs, Law LC 126/2006, which established a fiscal framework for small business. Later, the government enacted LC 12/200, creating the concept of the “*empreendedor individual - EI*” meaning individual entrepreneur—allowing sole traders to be formal companies. In early 2011, these new companies numbered 977,000; the number was then projected to rise to 1.5 million by the end of 2011.

After the launch of the Solid Waste Law, the Ministry of Environment (MMA) and SEBRAE signed an agreement to develop projects and programs related to environmental sustainability with micro and small enterprises. The objective is to offer technical and management capacity to SMEs on the new rules and how to implement them. The activities will include capacity-building of individual e-waste collectors, bringing them into the individual entrepreneur legal

framework. However, concerns regarding unqualified collectors and the potential health and environmental liability they bring remain strong, even though the collectors are now formal companies.

Successful business models

Model 1: ITAUTEC S/A (www.itautech.com)

ITAUTEC is a national company, manufacturing computers and hardware for bank and commerce automation. The company belongs to one of the largest groups in Latin America, the ITAUSA Group, which includes ITAU Bank. ITAUTEC has been in the professional electronic equipment market for more than 30 years, developing hardware and software. It has more than six thousand employees. In 2009, the company was the only Brazilian company listed among the 25 biggest banking solutions providers, in the FinTech100³ ranking. In Brazil, ITAUTEC is considered a model for green IT.

ITAUTEC's recycling process is based on reverse logistics in line with the new Law of Solid Waste.



ITAUTEC executes the disassembly and recycling process in Brazil, and exports components such as printed circuit boards to abroad for the extraction of valuable materials.

ITAUTEC performs its recycling process and disassembly activities at its manufacturing plant in Jundiaí, about 50 km from São Paulo city. The annual recycling volume is about 120 tons. The company brings its old ATMs to a plant where they are cleaned, and their physical condition is analyzed to rescue the sophisticated mechanical parts that can be used in the rebuilding process. The electronic parts are sent to the e-waste process. If the ATM is too damaged to be useful, the whole product follows the e-waste path. The company is currently only collecting e-waste from business clients, but it is developing a new strategy to collect from individual users around the country.

Model 2: PHILIPS BRASIL (www.philips.com)

PHILIPS Brazil is part of the multinational Philips conglomerate, and has been manufacturing electrical and electronic products in the country for more than 80 years.

The company manufactures electronic/electrical goods in the Manaus Industrial Pole, PIM. In 2009, Philips started its reverse logistics recycling process in Manaus. It now has 25 urban regions under the program, treating its full portfolio of brands, including Philips (electronics) and Walita (domestic electricals). The potential for collecting, transport and recycling in 2010 was 200 tons per annum, and the total collected and recycled in 2010 was 92 tons, with clear potential to expand. Besides its external partners, the company recycling system includes a call center and a chat center

(www.philips.com.br/support), a dedicated website (www.sustentabilidade.philips.com.br), forty collection points, and an optional service to collect directly at consumers' homes.

However, an economic analysis performed by Philips shows that this initiative is not covering its own costs. Company cost analysis for 2010 showed that the e-waste activities generated only 38% of costs via income from extracted valuable materials. Phillips itself provides about two-thirds of the running costs.

These activities are not currently sustainable on a cost recovery basis and may need to be reconsidered in the future if this does not change.

Model 3: CARREFOUR (www.carrefour.com)

Carrefour is a French retail chain that has been in Brazil for more than 35 years, with more than 170 stores. Carrefour brought the hypermarket concept to Brazil.

In January 2010, Carrefour launched a partnership with logistics partner, DescarteCerto for the collection and delivery of e-waste to recycling partners OXIL and Diassolog. Customers pay for the service, and it can be done at purchase or disposal. It is not currently a for-profit activity based on cost recovery.

By March 2010, the number of clients who had applied and paid for the service had reached just 550. The service is not cheap in local terms, costing approximately US\$2.30 for cartridges and US\$89.00 for refrigerators. Carrefour anticipates the service will represent 10% of its domestic appliance sales by 2012, which means about 3,000 to 5,000 items for disposal each month.

Initial customer surveys indicate only 1 in 10 customers is in favor, although this figure rose to 6 in 10 when respondents were told the service would collect products from the home or office.⁴

Model 4: OXIL – Manufatura Reversa (www.oxil.com.br)

Oxil is a Brazilian company with 15 years' experience recycling electronic, electrical and medical equipment. Oxil receives e-waste from 50 manufacturing companies around the country. Besides professional electronics and printer cartridges, Oxil recycles refrigerators, extracting CFCs. The company guaran-

tees around 85% of recycling for its clients, and at the end of the process it issues a certificate to its customers attesting to the final destination of the e-waste. Its base in Paulinia, a municipality 100 km from São Paulo city, holds several certifications—including ISO 14001— and local certificates from environmental and health public agencies.

Oxil follows *TAPA* (*Transported Asset Protection Association*) criteria on the protection of assets of the ICT industry. The objective is to prevent any part of the branded technology products of clients back onto the secondary market. Oxil's clients include Carrefour, Philips, Apple and Santander Bank.

Model 5: RECICLO AMBIENTAL (www.recicloambiental.com.br)

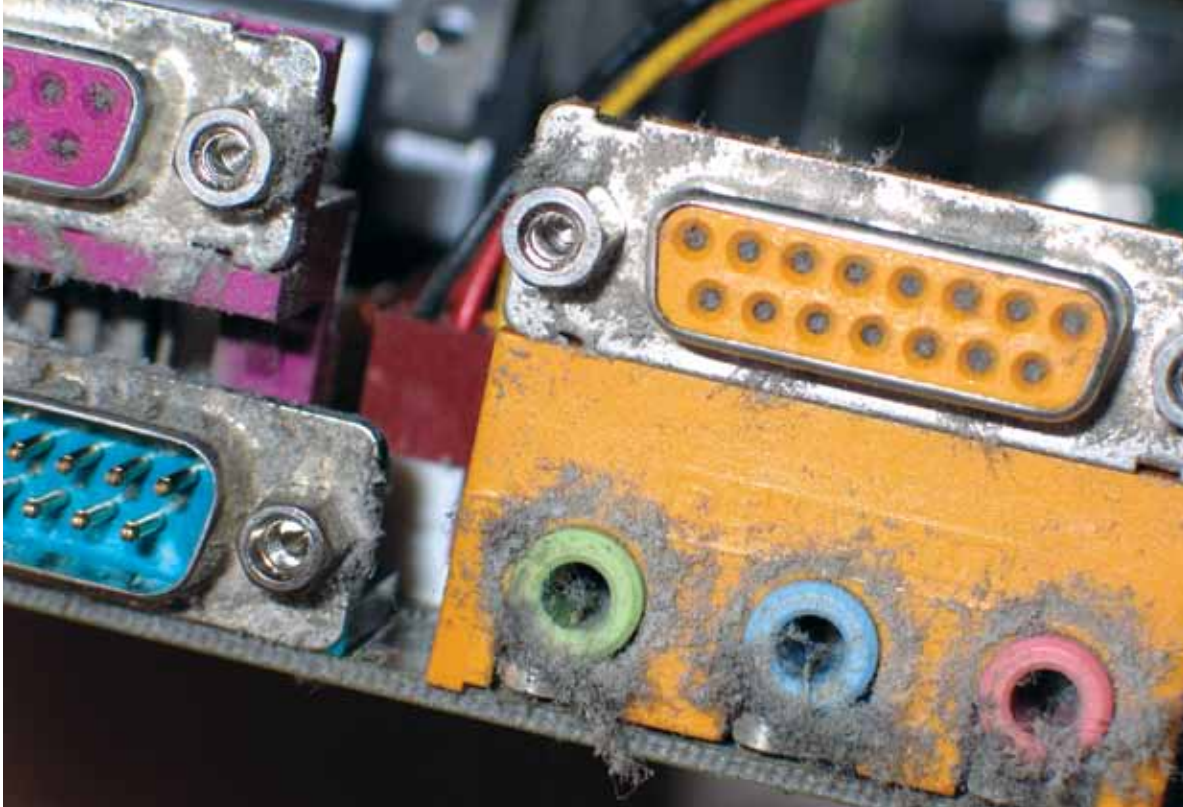
Based in São Paulo city, Reciclo Ambiental is a smaller company employing about 15 people. It runs an e-waste certified facility that serves manufacturing and brand-owning clients anxious to prevent their products from being sold on the secondary market. Reciclo Ambiental manages the whole e-waste process

and offers consulting on the internal organization and management of e-waste for manufacturing clients or large users of electronic/electrical products.

Reciclo Ambiental collects e-waste material from the client and delivers it to its own facility to be processed. It protects the brand, technology and data contained in all disposed materials. Reciclo Ambiental disassembles electronics, processes the components and exports elements such as printed circuit boards to Belgium for refining and extraction of valuable materials. Reciclo Ambiental also offers clients a Certificate of Destination, assuring clients that their e-waste has been dealt with in an environmentally sound way.

Reciclo Ambiental has launched several initiatives with municipalities, designing and organizing “e-waste day” or “e-waste week.” It also participates in federal government projects to train and build local recycling capacity and rebuild computers in the slums of Rio de Janeiro.

Reciclo Ambiental has a partnership with not-for-profit organizations to give training and certify programs, including with the USP-LASSU, Oxigenio,



or participating in public projects, such as the Open University, to educate the public about environmental responsibility.

Model 6: UMICORE (www.umicore.com.br)

Umicore is part of the Umicore Group, including the well known recycling company Umicore in Hoboken, Belgium. Umicore deals with energy, materials and performance materials and catalysts from the automotive, oil refining and petrochemical industries. The group has 14,000 employees in 36 countries, and 75 industrial plants in around the world, including one in São Paulo.

At its refining plant in Hoboken, Umicore processes 300,000 tons a year and more than 200 different types of raw materials. These include spent material catalysts from oil refining and petrochemical plants, spent catalyst materials from end-of-life cars, catalysts and e-waste materials such as printed circuit boards, mobile handsets and connectors. Its focus is on recovery of precious materials.

Umicore's international facility has a recovery yield for gold of more than 95%.

In July 2003, Umicore bought the plant of a company that had dealt with gold waste, in Guarulhos, near São Paulo city. The plant employs around 600 employees, producing high-tech products for the automotive, chemical, petrochemical, pharmaceutical, electro-electronic, and jewelry sectors, as well as recycling and refining metals.

Alongside its work recycling and refining metals, Umicore exports e-waste from Brazil to its Hoboken facility in Belgium. The company guarantees the correct destination and assures payment for precious materials recovered during its the refining process.

Umicore collects e-waste from the local recycling companies, processes some materials in Brazil, and exports the rest to its international units. Other competitors are now setting up similar bridge facilities in Brazil, encouraged by the existence of the new legal framework.

Umicore also promotes public awareness of e-waste through various projects.

Model 7: OXIGENIO (www.oxigenio.org.br)

Oxigenio is a not-for-profit organization with a peculiar Brazilian role as a civil organization in the public

interest that can receive resources from all levels of government. Oxigenio started its operation in the city of São Paulo in 1998.

The organization focuses on training people to rebuild computers for social purposes.

Oxigenio is also involved with initiatives involving tele-centers, local social organizations and public schools. Oxigenio also maintains its own centers named “Espaço Social da Juventude” in São Paulo city and the cities of São Bernardo, Santo André and Guarulhos, in São Paulo state, and Maceio, Alagoas State in the Northeast region. In total, Oxigenio has qualified 983 persons to process e-waste.

Analysis of business models

Transportation is the major e-waste processing cost, at about 50% of total process cost inside Brazil. This is a considerable challenge, given Brazil's size and distribution. As the Philips case shows, even large manufacturers are not yet generating e-waste profit.

ITAUTEC has a balanced cost recovery model because its operation does not rely on e-waste processing alone; significant income is generated by selling on refurbished ATM equipment. Also, Itautec does not deal with the individual users directly, only large users, reducing the cost.

Retailers' and telecom operators' models may be cost-neutral if considered as part of a loyalty-building client service, but e-waste is not their core business. Broadening the activity will require building scalable partnerships with e-waste specialists.

Significant revenues can be extracted from exporting e-waste; for example, a container of e-waste printed circuit boards is worth around US\$150,000 to \$180,000 if exported to a refining company. The time frame to receive the payment for precious materials extracted is around four months. Small companies may not be able to wait so long to receive payment. Hence, there is value in considering intermediaries to handle export administration and cash flow.

Consulting companies and independent recycling operations can be profitable, though the logistics—particularly collection—need to be carefully managed to maintain profits. Negotiations with producers are critical to guaranteeing profitable operation.



Keys for success for e-waste processors currently include maximizing volume and minimizing costs, particularly transport costs:

- Focus on large clients rather than consumers.
- Partnerships with recycling certified companies, to guarantee the legality and security of the process, avoid liabilities and make the exercise worthwhile for both parties.
- Different clients around the country demand regional solutions. Transportation costs are key.
- Export directly, using bridge companies in Brazil, or directly with external partners, taking into consideration the time frame to receive revenues.
- Consider partnerships with other large producers to coordinate transport and lower costs. Offer regional facilities or services to attract large producers.
- Grow faster to respond to the demand the new national legal framework creates.

However, no single model fits all cases. The current trend is for associations of regional producers to cooperate to with e-waste, achieving higher volumes to reduce transportation costs.

The new legal framework has prompted the emergence of many new recycling companies. However, some newcomers may fail because of lack of expertise, high costs, time required to get certifications, and bureaucratic procedures. Partnerships with existing companies in the market may help.

The demand for e-waste processing will continue to grow, but the changes needed in individual and company behavior in order to increase volume, as well as the emergence of a mature market, will take time.

Interviews with stakeholders indicate that Brazil is more prepared to deal with e-waste than other developing countries because it still has a relatively low volume of illegal commerce of waste.

Chapter 5

CHALLENGES AND OPPORTUNITIES: BRAZIL

With a national strategy transformed into a legal framework to address the solid waste challenge, and with a formal sector agreement with industry to be concluded in the first half of 2012, it is time for Brazil to consider its role in the global e-waste arena.

As the largest country in South America, and with a relatively well developed legal framework on e-waste, Brazil might import and process e-waste and develop the processes and facilities to extract precious materials from it. Successfully undertaken, this could attract a significant number of high-quality jobs to Brazil. The key question is whether Brazil should consider encouraging a capital-intensive processing facility to undertake the processing activities currently exported to refineries abroad.

Currently, less than half a dozen advanced refining facilities exist globally to extract all precious materials from e-waste. As the Umicore example above shows, they require a large throughput of waste annually in order to be profitable. The level of investment required to match existing facilities, and the current logistical challenges to maintaining a sustainable volume of e-waste, mean this is not a short-term solution.

Regarding importation of e-waste from other Latin American countries, issues to be considered include:

- Relations, interests and agreements with other Latin American countries, and the possible need to harmonize legislation and certification—would this be mutually beneficial to Brazil and other countries?



- Transport, taxation and administrative issues and legal liabilities, including those specifically related to export of e-waste.
- Border controls dealing with illegal e-waste importation.
- International knowledge-sharing and capacity-building needs.

Careful evaluation needs to be done to determine if the outcome of these activities is likely to be favorable and worthwhile. Any initial consideration of developing highly specialized processing facilities in Brazil should be done on the basis of the likely domestic volume of feedstock. Nonetheless, Brazil should consider which parts of the value chain it could profitably specialize in, for example, disassembly and treatment, with subsequent export for refining.

Chapter 6

DETAILED RECOMMENDATIONS FOR BRAZIL

It is unrealistic to think that all questions will be answered by the initial sector agreements between the MMA (Federal Environment Ministry) and Brazilian industry. The consultative process will need ongoing elaboration. Key implementation questions for further consideration include:

- How best costs and opportunities can be spread throughout the life cycle (and indeed, how much intervention is desirable to determine these outcomes).
- How to monitor and enforce implementation.
- For each material, what the recycling targets are.
- What the overall impact on the economy is.
- The role and participation of the public.
- How to gather the right data together to monitor and improve the system.

The following recommendations are offered as guidance during the collaborative process of legislative implementation.

Recommendation 1: States need to harmonize their regulations with the federal law

Several states and some large municipalities already have legislation on solid waste and specifically e-waste, some of which were published before the federal law. Local agreements should be aligned with any agreement established with the federal government. It is particularly important that the allocation of costs and

responsibilities along the value chain be consistent throughout.

Recommendation 2: Deal with gray market, orphan, and refurbished unbranded products

Gray market and orphan products should be collected and handled with financial support from a central fund calculated according to manufacturer percentage of national sales.

Recommendation 3: Prioritize capacity-building

Training and capacity-building is an important focus for e-waste policy success, and should be encouraged in tertiary level education as well as basic qualifications and training. Raising public awareness is essential.

- Invest in and develop training at technical, graduation and post-graduate levels on e-waste related courses, such as engineering, environment and business.

Recommendation 4: Use the certification process and guarantees to formalize the informal sector

The correct e-waste final destination guarantee is critical for success. Currently, certificates are awarded by environment agencies around the country, using different priorities and criteria. International certifications are too burdensome and there is a need to build



a harmonized system, valid for all Brazilian states, at more realistic prices.

- Define environmental e-waste requirements for compliance, defining different levels of compliance.
- Recycling companies of all sizes, transportation companies and collecting cooperatives should all be certificated under the same criteria.
- See Recommendation 5 below regarding environmental impact certifications, to include them as part of the capacity-building and certification process
- Develop a national network of affordable authorized certification organizations.
- Recognize valid international certifications.
- Review procurement law to stimulate the development of the certification process.

Recommendation 5: Evaluate the feasibility of domestic refining of e-waste

More effective manufacture and refining of valuable materials within Brazil may create business opportunities.

- Analyze incentives under existing laws to promote eco-design in manufacturing.
- Sponsor technical and economic studies to investigate whether it is economically feasible to implement the full e-waste refining process in Brazil, analyzing economic, political and strategic issues such as:
 - ♦ The costs and benefits, including employment, of refining e-waste to extract valuable substances versus export.

- ♦ The relevant trade balance with Mercosur versus the export alternative, to determine if there is potential extra value for Brazil.
- ♦ If the results indicate the development of Brazil's refining capacity, request or encourage FINEP (Financiadora de Estudos e Projetos, www.finep.gov.br) to support different developments around the country, involving local strong metallurgical companies as partners.
- ♦ Support technology transfer, as necessary, to accelerate the process.
- Promote groups to debate standards (COBEI/ABNT, www.abnt.org.br), process requirements, inventory of product life cycle (life-cycle analysis), etc.

Recommendation 6: Create clear incentives, financing, and enforcement

As described above, collecting and processing e-waste is not currently profitable, and incentives may be required. This option may need to be studied alongside the incentives of Extended Producer Responsibility (EPR). However, it is important to remember that one of the e-waste problems even in Europe is also lack of enforcement, so further action on the enforcement side should be considered.

The professional electronic sector in Brazil creates incentives under the Informatics Law that promote local technology development. Similar incentives for e-waste should include:

- Finalize, as a matter of urgency, the sector agreement with industry. This should have harmonization as its goal but take into account the different realities in each region of the country and establish



Photo Credit: Keoni Cabral



goals according to the level of capacity (i.e. ability to collect e-waste, local legal framework, volume of e-waste, public awareness) of the regions.

- Develop new processes and equipment for e-waste at certificated research centers.
- To promote the involvement of individual entrepreneurs, offer incentives to support their training and formal certification.
- Develop BNDES (Banco Nacional do Desenvolvimento) financing to stimulate merging and acquisitions to build scale in organizations in the sector.
- Require public waste collectors to accept and appropriately direct e-waste. This may need to be done at the municipal level and include local dissemination of information on how to deal with e-waste.
- Develop and require municipal enforcement by local authorities, relevant to their size and capacity.

Recommendation 7: Prioritize industry and public awareness-raising

The lack of knowledge among companies, especially SMEs, and the general population, combined with a lack of information easily available about how to deal with e-waste, are strong impediments to progress.

- Invest in campaigns to inform relevant companies and the public.
- Encourage all responsible actors under the federal law (producers, importers, distributors, retail companies) to offer and publicize their collection and drop-off facilities.

- Consider including a requirement for ICT advertising materials to include brief guidance on e-waste disposal.
- Develop and disseminate, together with NGOs and companies, booklets for public and private schools to teach children about the environmental risks of e-waste.

Recommendation 8: Optimize transport rules and taxes

Lack of harmonization between state laws generates unnecessary costs both in taxes and in trips to collect e-waste. São Paulo State, for instance, provides—per its Decree 45,490/00 (RICMS/SP), Art. 392—for a 100% deferral of merchandise circulation tax (known as ICMS), but e-waste is not included. Also, the use of the same vehicle to deliver new ICT products and simultaneously collect e-waste is currently forbidden, under inappropriate hazardous waste transportation rules.

- Harmonize ICMS deferral for all states, including e-waste.
- Allow the use of same vehicle to transport electronic products and electronic waste.
- Create a more flexible system for the user to transport the e-waste, allowing, for instance, the producer or recycler to issue receipts when they receive used products from individual users.

Recommendation 9: Evaluate trade opportunities

Brazil could play an important international role on e-waste, especially within Latin America. If the cost-benefit analysis shows it is worthwhile for Brazil to

invest heavily in domestic refinement capacity, steps will need to be taken to ensure a higher volume of e-waste is sourced from other Latin American countries. Relevant steps in this regard could include:

- Setting up a specific group under the Committee for Trade and Environment to negotiate on e-waste.
- Working to promote and/or harmonize the legislation for solid waste with neighboring countries.
- Incorporating transport groups in such discussions regarding hazardous transport, to remove barriers.
- Defining a common list of e-waste products for the purpose of cross-border commerce, and harmonized criteria for certification, to avoid environmental risks, smuggling and public health issues.
- Using the opportunity of RELAC study (Regional Platform on PC Electronic Waste in Latin America and the Caribbean⁵) to fully involve other Latin American and Caribbean countries in such negotiations, building a harmonized framework region.
- Exchanging knowledge among countries, including sharing learning and materials, to improve commerce and reduce environmental and health risks.

Recommendation 10: Don't forget the plastic segment

Plastic waste is also a significant part of e-waste, although in Brazil it will be managed by a separate sector agreement. However, relevant recommendations to that sector can also be made:

- Work to eliminate the regular selection of plastic in the waste process, particularly given plastic's longevity in landfills and the health problems created by informal processing methods such as burning.
- Train e-waste processors on the correct disposal of plastic waste.
- Create low-cost kits to deal with disassembly of plastic parts by collectors.

Recommendation 11: Industry must shoulder its responsibilities

Industry and government are still working together to create a sector agreement in the first half of 2012. The above recommendations may help building agreement, but they are focused on government activities. These recommendations are directed to industry and focus on making e-waste collection and processing more financially sustainable:

- Consider different business models for sustainable e-waste processes. There is no one model for the whole industry or for all products and regions.
- Agreements among producers focused on one specific product can drive cost reduction.
- Cooperative agreements between manufacturers, distributors and retailers on e-waste collection may reduce costs.
- Make it easier for customers to return end-of-life products. For example, in Japan, a fee paid when buying a PC generates a document that can later be used to box and mail a used PC with the post office.
- As in Recommendation 5, it is important to pay attention not to establish goals for the entire country. Regional differences and maturity demand sequential goals in time to each region following each degree of maturity for e-waste.
- Set realistic but progressive recycling targets to drive expectations, establish a barometer to analyze outcomes and increase political will and stakeholder commitment.
- Following conclusion of the sector agreement with the government, define an industry seal to certify companies that follow the agreement.
- Guarantee that relevant and accurate retail data is available in a timely way to public agencies, to allow the development of sound policies.

Chapter 7

SUMMARY CASE STUDIES FROM EMERGING ECONOMIES

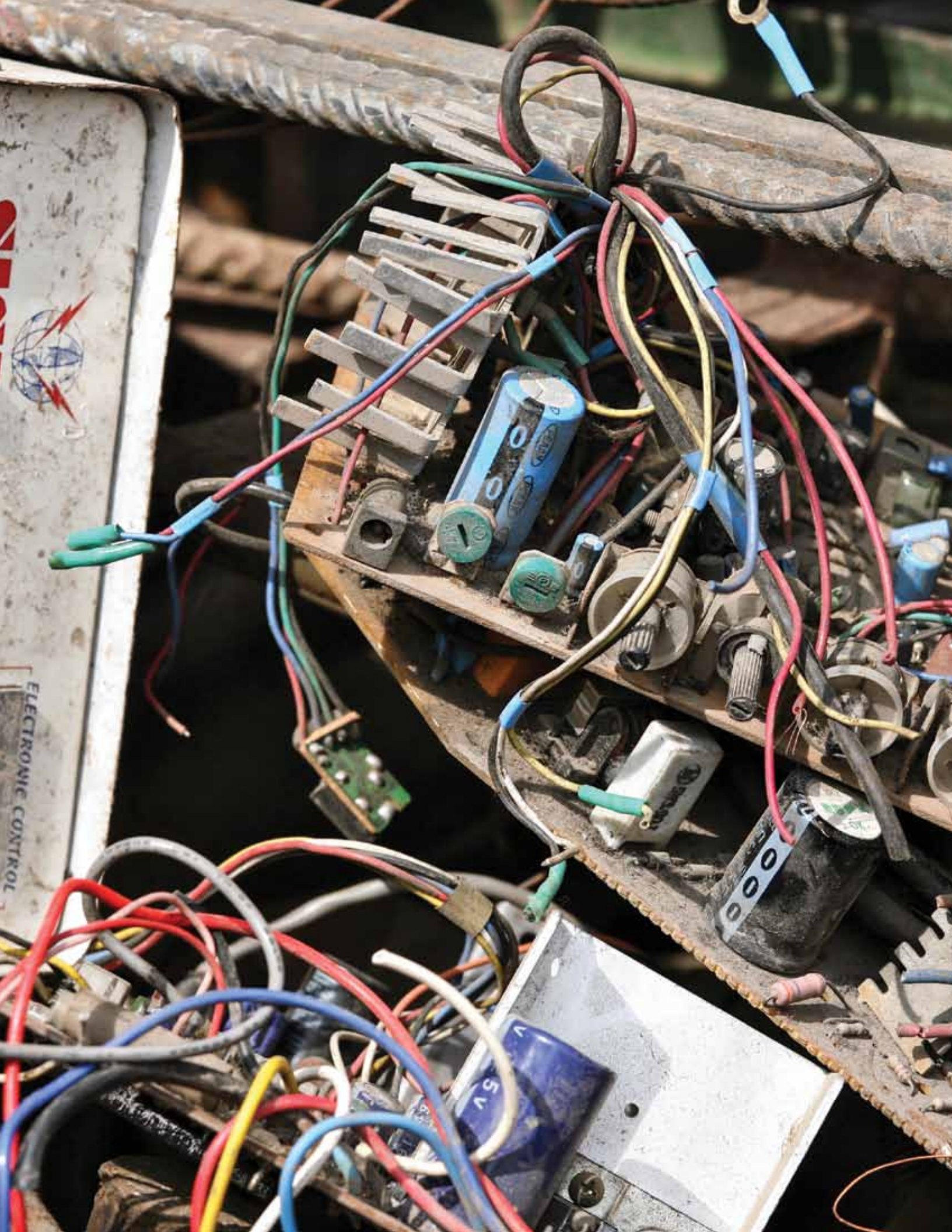
India	Strengths	Weaknesses
<p>As of the date of this publication, there is no enacted law specifically regarding e-waste. However, this should be changing in the near future, as an E-Waste (Management and Handling) Rules 2010 was drafted in March 2010. It is unknown when it will be voted into law, and whether changes will be made to the current draft before ratification. As such, the rule is progressive in nature as the first time producers are responsible for the entire life cycle of the product, from the design to waste. If ratified, the rules will:</p> <ul style="list-style-type: none"> • Lay emphasis on extended producer responsibility including financial responsibility in order to set up effective collection systems for the proper management and handling of e-waste. • Define and include stakeholders in the scope of e-waste responsibilities, whether it be the dealers, refurbishers, dismantlers, collectors, recyclers or the government agencies for implementation and monitoring. • Ban the import of used electrical and electronic equipment for charity in the country. • Advocate "Restrictions on Hazardous Substances" and the need to restrict such substances in electronic equipment. <p>The formalization and organization of the informal sector is a crucial element in ensuring constant e-waste flows for collection and treatment.</p>	<p>A considerably open dialogue among relevant stakeholders (NGOs, government agencies, producers, recyclers, collectors) is helping the government to move quickly to define India's e-waste strategy.</p> <p>Some voluntary take-back initiatives are already underway (Nokia, for example).</p> <p>Awareness-raising campaigns in the community often accompany formal recycling activities, although not always on a large scale.</p> <p>National e-waste legislation can act as a potentially strong driver for proper e-waste management.</p> <p>A successful initiative to integrate the informal sector in Bangalore is serving as a model to be reproduced in other Indian cities.</p> <p>Awareness-raising by public and private actors could serve to increase consumer knowledge about e-waste and increase collection rates.</p>	<p>The lack of formal policy in India regarding e-waste is a major hindrance to the organization of the collection and recycling process.</p> <p>The drafted legislation does not outline collection and treatment schemes, nor does it provide incentives (financial) for the involvement of the informal sector.</p> <p>Past environmental legislation has been poorly enforced, and if reproduced for e-waste legislation, the movement for proper e-waste management will be threatened.</p> <p>There are very few formal e-waste treatment centers. Technology and facilities already exist, but more need to be developed to handle the potentially large volumes of collected waste.</p> <p>Insufficient awareness-raising measures to date have e-waste stakeholders and notably consumers in the dark about the importance of the issue.</p> <p>Licensing guidelines for treatment facilities are not yet streamlined by the Central Pollution Control Board.</p>

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South Africa	Strengths	Weaknesses
<p>Solid waste—both hazardous and non-hazardous—is regulated by several acts, most recently the 2009 Waste Act, though the breakdown of the roles is not precisely defined between manufacturers, retailers, consumers and municipalities. One of the essential elements of the Waste Act is that manufacturers and importers must define an Industrial Waste Management Plan (IWMP) before selling products in South Africa (in principle, this is equivalent to an EPR). The role of retailers is not defined. This obligation is not coercive. No specific financial legislation was taken to enforce a specific financial scheme.</p> <p>The informal sector does not focus on e-waste as dismantling e-waste to get to the valuable materials is generally too complicated. Cables and CRT copper coils are the main exceptions. Cooperation with the informal sector also takes place, with a small retribution of scavengers that bring back e-waste.</p> <p>Producers and importers gathered in the e-Waste Association of South Africa (eWASA) to implement their IWMP. Its operational and financial design is still ongoing.</p> <p>In Cape Town, five companies work on e-waste recycling or refurbishing. Those are small-scale companies and are rather new. A bigger company, Desco, exists in Johannesburg and has been operating for 15 years.</p>	<p>Financial and operational support from Swiss EMPA enabled launching and developing actions regarding e-waste management in Cape Town. A pilot was launched under the collaboration of small recyclers and bigger producers.</p>	<p>The existing legislation is not precise enough on the fiscal and financial scheme and on the breakdown of responsibilities between companies and public bodies. This may hinder the development of a large-scale e-waste management scheme. Furthermore, the law is not coercive, which may not foster speeding up the process.</p>
	<p>Existing legislation makes the definition of an IWMP compulsory for producers and importers. Those actually develop IWMPs through eWASA, a non-profit organization.</p>	<p>There is no large-scale solution for the treatment of e-waste in South Africa. Regulation exists but collection is not organized, which makes it difficult for small businesses to reach a financial balance and for bigger recyclers to develop at the national level.</p>
	<p>The Consumer Protection Act forces retailers to accept take-back from consumers buying a new product.</p>	<p>In some cases, small recycling companies and bigger producers have not found a compromise yet between financial capacities of the first and environmental policy requirements of the latter.</p>
	<p>Scavengers are more and more kept out of the landfills, which make it easier to develop recycling businesses. They may then collaborate in the collection process.</p>	<p>The development of IWMPs is deemed too slow by some of the non-eWASA actors.</p>
	<p>Awareness on the need to control second-hand e-product imports is increasing.</p>	<p>There are not enough downstream industrial users of recycled waste to enable the management of all by-products.</p>
	<p>There are High Hazardous Waste Landfills that provide a solution for the management of some non-recyclable elements.</p>	
	<p>EPR is already actually enforced for plastic bags and tires.</p>	

Costa Rica	Strengths	Weaknesses
<p>Prior to establishing a regulation, a diagnosis of the e-waste management situation in Costa Rica was completed. Small businesses collecting solid waste were also collecting e-waste from companies, shops and repair shops, all of it transported together and taken to treatment plants, illegal dumps or final disposal sites. There was no separation in collection and recycling was scarcely developed in Costa Rica, with only a few small “collection centers” recovering recyclable materials, as well as a small informal sector composed of “buzos” collecting materials from the street or from final disposal sites. The problem identified was the lack of effective mechanisms allowing consumers (the general public as well as companies) to return electronic equipments for an appropriate treatment at the end-of-life stage.</p> <p>In May 2012, Costa Rica approved comprehensive producer responsibility regulations for electronic products that established the principles for the Extended Producer Responsibility (EPR) through registered “Compliance Entities”, which are required to present compliance plans, meet benchmarking targets, and undertake reporting and public awareness activities.</p> <p>Some attempts have been made at formalizing the informal sector, for example with the founding of the <i>Asociación de Recuperadores de Tirrases</i>, regrouping 76 persons from the informal sector, 10 of whom specialized in the recovery of electronic equipment, thanks to basic training on electronics.</p>	Study of Costa Rica’s situation regarding e-waste prior to the drafting and launching of legislation.	Difficulty to access and compile information in a country where there is very little available data and no follow-up on e-waste.
	The project and its outcomes (National Strategy and Executive Committee established by law) benefited from the study of Holland’s best practices and from a visit of the Technical Committee on site.	Having so many actors round the table implies great efforts to reach consensus on strategic issues.
	Identification of the key actors and stakeholders for efficient national e-waste management.	Delays in the implementation of the project because of the absence of clarity of competencies on e-waste at the state level.
	Inclusive process with the participation of NGOs, private sector companies, government agencies and the academic sector in a National Technical Committee that oversaw all the process.	
	Establishment of an Executive Committee that will oversee the operational implementation of the national strategy for e-waste.	



Chapter 8

INTERNATIONAL BENCHMARKING: SUMMARY OF CHALLENGES AND OPPORTUNITIES

The case for strong regulation	<p>The existence of an adequate legal framework is a fundamental precondition for the establishment of a sound e-waste management system in any given country. It lays the groundwork for the elaboration of the specific roles and responsibilities among e-waste actors and allows for the definition of implementation mechanisms and institutional support, as well as enforcement measures.</p> <p>The case for legislation stems from its role as an essential driver in mobilizing and fostering key success factors for sustainable e-waste management. Indeed, the profitability of e-waste recycling is strongly linked to the existence of burden-sharing and financing schemes (eco-taxes) defined in legislative framework. Such schemes allow for recycling targets to be achieved, partly compensating collection and recycling costs, while creating the necessary economic incentives to spur business development and job creation.</p> <p>Access to feedstock is probably one of the most significant issues that players and stakeholders will have to face in emerging countries. In light of that, the establishment of a regulatory framework also serves as a means to harness e-waste collection into an organized waste flow for recyclers.</p> <p>Finally, legislation sets the standards for e-waste treatment by which producers, recyclers, and consumers must abide.</p>
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Beyond a piece of paper: an e-waste roadmap	<p>The establishment of national or supranational legislation concerning e-waste has to specify:</p> <ul style="list-style-type: none">• Financial considerations—outlining a scheme by which producers are responsible for the costs of picking up e-waste from collection facilities and the costs implied in refurbishing waste products for reuse or for recycling and recovery.• Collection and recycling targets—reasonable and progressive targets for e-waste treatment as defined by a legislative framework can help incite and promote the process.• Transborder movement of e-waste.• Supervision of recycling standards.• Enforcement of the regulation.
Best in class: the European Union's E-Waste Directive	<p>The most widely influential and replicated legislative framework for the management of e-waste is the European model. The European e-waste market is strongly influenced by the EU-Directive 2002/96/EC, the directive on e-waste and its national transpositions. The E-Waste Directive is based on the principle of Extended Producer Responsibility (EPR), which is a guiding principle of the European recycling strategy.</p> <p>Based on the premise of extended producer responsibility and the fact that improved product design can better facilitate recycling and disposal of end-of-life products, the key objectives of the E-Waste Directive are to:</p> <ul style="list-style-type: none">• Reduce e-waste disposal to landfills.• Improve product design with a view to both preventing e-waste and increasing its recoverability, reusability, and/or recyclability.• Achieve targets for recovery, reuse, and recycling of different classes of e-waste.• Provide for the establishment of collection facilities and separate collection systems for e-waste from private households.• Provide for the establishment and financing by producers of systems for the recovery and treatment of e-waste, including provisions for placing financial guarantees on new products placed on the market.

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The challenge for emerging countries	<p>With many developed countries having drafted and implemented e-waste regulation, emerging countries are more and more looking for best practices in order to create the most effective and adapted versions for their own nations. It is clear that a regulatory framework regarding e-waste acts as a key driver in structuring and driving recycling activities which are not sufficiently profitable at present, by setting mandatory recycling targets or by supporting the establishment of financing schemes for e-waste collection and recycling.</p> <p>Some keys to successful legislation, as outlined above, still have yet to be perfected, as can be seen with the case of enforcement. Enforcement of existing and future regulations on e-waste in emerging countries will constitute a challenge, as the informal sector will probably remain a major player on the market in the medium term, even with the adoption of new legislation. To counter this challenge, maximum efforts should be made to ensure that the necessary resources for proper enforcement in emerging countries will be applied.</p>
The value of Extended Producer Responsibility	<p>EPR is defined by the Basel Convention as an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle. Two related features of EPR policy include:</p> <ul style="list-style-type: none"> • Increasing producer responsibility by shifting responsibility upstream towards the producer and away from municipalities and/or regional or provincial waste management authorities. The issue is the internalization of a cost that is currently borne by society at large. • Providing incentives to producers to incorporate environmental considerations in the design of their products. <p>EPR has rapidly gained popularity in countries where the management of e-waste has been put forward on the political agenda, for it has the potential to stimulate producers to design long-lasting, environmentally friendly and easily recyclable products.</p>
Creating multiple stakeholder involvement to facilitate sector transformation	<p>Engaging all the stakeholders is a key success factor to develop a national policy on e-waste. Though reaching a consensus is a lengthy process, government, local institutions, producers, importers, retailers, refurbishers, recyclers, dismantlers, scavengers, NGOs, and academics will need to be involved so as to guarantee their support and benefit from their experience regarding the issue at stake. One essential actor not to forget is the public. If it cannot formally be included in the process, it is nevertheless important that its awareness be raised. In the case of e-waste management, the public is a crucial part of the collection and treatment phases.</p>

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Optimizing collection by planning ahead and creating awareness

Progressive recycling targets could be set to create momentum. Quantitative objectives are a key aspect. Targets notably serve to:

- Push recycling actors into action and create momentum.
- Set expectations on the part of the government and express national e-waste management ambition.
- Establish a performance barometer to analyze short, medium, and long-term outcomes.
- Incite closer management of strategies and programs.
- Increase political will and stakeholder accountability regarding e-waste management.

However, unrealistic objectives prove counter-productive. When overly ambitious or unrealistic targets are set, not only will objectives most likely remain unmet, but political and stakeholder repercussions will result. It is thus of the utmost importance to set progressive and realistic recycling goals to accommodate the substantial change taking place in e-waste management.

Formalizing the informal sector with the help of neutral parties

Capturing the informal sector is a key to success in e-waste management. Large informal sectors are often prevalent in developing countries or emerging economies that lack enforced formal policy regarding e-waste collection and management. Despite their key role in the e-waste management industry, informal actors notoriously handle this waste in an environmentally unsound manner (for example, manual dismantling of hazardous materials and open-air burning), all the while putting their health and safety at risk.

However, with the ever-increasing volumes of e-waste being produced or exported to these countries, and with the growing interest among government officials and legislative bodies, formal recycling actors are emerging to create viable business solutions using safer recycling technologies. It is essential that the informal sector be captured in this process, not only to reduce environmental and health risks (by modulating fees according to environmental practices, for example), but also as their participation is key to accessing large enough volumes of feed material for recycling. Furthermore, the informal sector's participation would equally serve to drive down collection costs and allow for the creation of green jobs.

Capturing the informal sector is not an easy feat for numerous reasons:

- Informal actors are often individual entrepreneurs that operate to survive on a day-to-day basis.
- Large informal sectors are composed of sometimes thousands of diverse actors that never collectively work together.
- Government and private sector attempts to engage with informal sector actors have resulted in hostile reactions or rampant unwillingness to cooperate.
- Scrap dealers and recyclers often pay better prices for e-waste collection as compared to formal recyclers, who are burdened with high overhead costs to meet environmental compliance requirements.

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	Thus, a comprehensive approach must be taken in order to establish a lasting and productive dialogue that will allow for the progressive integration of this largely untapped resource for e-waste feedstock and economic opportunity. Using an intermediary association with a global perspective on best e-waste practices is ostensibly the best approach for ensuring success. Ideally, such an association should be trusted by all stakeholders and have a solid footing.		
A model for emerging economies: export to the experts	E-waste recycling outputs are composed of potentially reusable parts (obtained during the dismantling phases) and of the various materials entering the composition of the product.		
	Material contents	Value	Characteristics
	Ferrous metals	Average	High amount in e-waste collected.
	Non-ferrous metals	High	Non-ferrous metals, including precious metals, even in small quantities, have a net positive value after recycling. Content of precious metals is decreasing in modern appliances.
	Glass	High → Low	Mainly in CRTs. As CRTs are being replaced by flat screens (LCD and plasma technologies) in Western countries, reusing glass so as to manufacture new CRT televisions & monitors will soon be impossible. New outlets have to be found.
	Plastics	Low	Plastics represent almost 25% of small household appliances. Plastic is very difficult to sort and requires expensive processes. New technologies are in development.
	Printed circuit boards	High	PCBs contain various metals (lead, copper, gold, silver, etc.). Quality discrepancies of PCBs entail inconsistent quantity of metal content.
	Reused components (other)	Average	Compressors, electric motors, integrated circuits (ICs), processors, hard drives, supplies from computers, etc.

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**A model for emerging economies:
export to the experts**

As seen in the table above, printed circuit boards and non-ferrous metals often found in IT and communication equipment are of particularly high value. Much disparity exists, however, in the methods used for recovery of precious metals, as there are only four large integrated smelters/refineries worldwide. Three of them are in Europe, namely:

- Umicore in Hoboken (Belgium)
- Norddeutsche Affinerie in Hamburg (Germany)
- Boliden in Rönnskär (Sweden)

In each case, e-waste is not the only input, and typically enters the process as a side stream: The very limited number of such facilities globally is due to the fact that economic operation is only feasible with a large scale plant and with significant investments in processing technologies and pollution prevention.

For developing countries where best technologies regarding metal recovery are quasi-inexistent, toxic chemicals are often used to recover these valuable metals, causing a direct negative impact to workers' health and to the environment.

Generally speaking, the market is not mature enough for complex treatments which require high volumes and are very capital intensive. For this reason, one viable option is for local industrial initiatives to focus on collection, segregation, crushing and disassembly, while sending outputs to Europe for end-processing and complex treatment (especially refining for PCBs).

Appendix 1

GLOBAL CHALLENGES AND OPPORTUNITIES IN DETAIL

The value of Extended Producer Responsibility

EPR is defined by the Basel Convention as an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle. Two related features of EPR policy include:

- Increasing producer responsibility by shifting responsibility upstream towards the producer and away from municipalities and/or regional or provincial waste management authorities. The issue is the internalization of a cost that is currently borne by society at large.
- Providing incentives to producers to incorporate environmental considerations in the design of their products.

In the framework of EPR, manufacturers are in the best position to control the longevity, content and recyclability of the products which they design. Therefore, it gives them an incentive to design products so as to minimize the costs involved with the end-of-life management of the product. The manufacturers take actions to manage their products properly at the post-consumer stage, with sustainable product designs (decreased use of toxic materials, use of recycled and recyclable materials, upgrade potential, and ease of

disassembly for repair and recycling) and participation in take-back and recycling programs. It is possible for the producers to split the cost of the financial and physical obligations related to the collection and in general the management of the e-waste.

EPR: a concept with a good track record in a variety of countries

EPR has rapidly gained popularity in countries where the management of e-waste has been put forward on the political agenda, for it has the potential to stimulate producers to design long-lasting, environmentally friendly and easily recyclable products.

The European e-waste market is strongly influenced by the EU Directive 2002/96/EC, which is the Directive on Waste Electrical and Electronic Equipment (E-Waste Directive) and its national transpositions. The E-Waste Directive is based on EPR, which is a guiding principle of the European recycling strategy. Producers are financially responsible for taking back their own products at end of life and managing them in accordance with the directive. Its national transpositions have mostly differed on the financing system for EPR (collective vs. individual responsibility).

Canadian provinces and states in the US have regulated on issues involving the financing system, and the organization of collection and recycling, and partly introduced the concept of EPR. The outcome of the different legislations can vary significantly from one



province/state to the next. However, Canada has recently issued guidelines to introduce a common Product Stewardship model, whereas a consensus could not be reached by the equivalent NEPSI initiative in the US.

The South Korean EPR law which came into force in 2003 requires producers and importers to achieve official recycling targets or face financial consequences. The law covers consumer goods such as air conditioners, TVs and PCs. Manufacturers and importers can either outsource their waste recycling activities to industry cooperatives and professional recycling companies or establish their own recycling facilities to meet the EPR requirements.

However, South African EPR is not precise enough and regulation is not deemed coercive enough to enable significant outcomes yet.

Regulation as a crucial first step and its subsequent benefits

The case for strong regulation

The existence of an adequate legal framework is a fundamental precondition for the establishment of a sound e-waste management system in any given country. It lays the groundwork for the elaboration of the specific roles and responsibilities among e-waste actors, and allows for the definition of implementation mechanisms and institutional support, as well as enforcement measures.

Emerging countries, on the whole, have not yet adopted legal requirements on the collection and recycling of e-waste that measure up to already existing legal frameworks in industrialized countries. Nonetheless, recent developments are taking place in some countries, and this should be a decisive factor regarding the emergence of a dedicated e-waste recycling sector, as has been the case for Europe.

The case for legislation stems from its role as an essential driver in mobilizing and fostering key success factors for sustainable e-waste management.

Emergence of new sustainable businesses via formal recyclers and collectors

The e-waste recycling industry regroups technology providers, eco-organisms, dismantlers and shredders, and precious metal refiners. The profitability of

e-waste recycling is strongly linked to the existence of burden-sharing and financing schemes (eco-taxes) defined in legislative framework. Such schemes allow for recycling targets to be achieved, partly compensating collection and recycling costs, while creating the necessary economic incentives to spur business development and job creation.

Umicore, a precious metals refining business based in Belgium, has emerged and flourished in Europe since the implementation of the 2002 European E-Waste Directive, and actively imports e-waste from developed and even developing countries that do not have the necessary technology for such material recovery. Other technology providers and major industrial recyclers are increasingly attracted by the potential of emerging markets and their underlying business opportunities. Legislation would help open the way towards foreign investment in the sector.

Improved collection rates

The establishment of a regulatory framework also serves as a means to harness e-waste collection into an organized waste flow for recyclers. Access to feedstock is one of the major challenges that stakeholders will have to face in emerging countries.

The case of Attero Recycling in India, where national legislation regarding e-waste is still pending, provides a stark contrast with Umicore in Europe. Attero runs its plant at below capacity, at least in part because competition from the informal sector reduces the volume of e-waste feedstock and also drives up its price. It is thus in the interest of stakeholders to push for legislation, as it can have a considerable impact on the availability of feedstock to recyclers and the emergence of level competition among e-waste actors.

Proper recycling standards

Legislation sets the standards for e-waste treatment by which producers, recyclers, and consumers must abide. As often is the case in developing countries, environmentally unsound methods such as open-air burning, stocking, or landfill use are regularly practiced. Outlining proper standards for e-waste treatment, combined with awareness-raising campaigns, is a first step in ensuring the responsible disposal and recovery of e-waste.

Beyond a piece of paper: an e-waste roadmap

The establishment of national or supranational legislation concerning e-waste represents far more than a piece of paper; it embodies a plan of action, most notably when it specifies:

- **Financial considerations.** E-waste legislation can act as a roadmap for those who will bear the costs of collection and recycling. Several different models exist, although the Extended Producer Responsibility principle is emerging as the most common and internationally accepted practice and outlines a scheme by which producers are responsible for the costs of picking up e-waste from collection facilities and for the costs of refurbishing waste products for reuse or for recycling and recovery.
- **Collection and recycling targets.** Reasonable and progressive targets for e-waste treatment as defined by a legislative framework can help incite and promote the process. Creating overly ambitious

Insight: Attero Recycling

In 2010, IFC agreed to invest up to US\$5 million in India-based Attero Recycling, an electronic waste recycling company. Established in 2008, Attero is an end-to-end provider of e-waste recycling services, with a presence across India. The company's operations primarily consist of sourcing and dismantling e-waste, as well as recovering key component materials like plastics and metals, including precious metals, which are then sold domestically.

Attero's e-waste recycling operations are organized in two units:

- Mechanical e-waste recycling (i.e. shredding, electromagnetic separation of ferrous materials and eddy current separation of plastics, aluminum and copper plus other metals).
- Precious metal extraction through smelting and electrowinning/ electrorefining of the residue after eddy current separation (i.e. copper plus other metals).

Attero also plans to build facilities for recycling glass (melting glass and converting to beads), extruding recyclable plastics to plastic granules and converting non-recyclable plastics to carbon black. Attero recently launched a pilot program to refurbish and sell old computers directly to end-users, schools and non-government organizations.

targets from the start, as was the case with e-waste legislation in Ontario, Canada, can play out as a factor for failure and disappointment.

- **Transborder movement of e-waste.** Of major concern in establishing e-waste legislation is the regulation of e-waste imports and exports. In recent years, developed countries have ostensibly taken to improperly disposing of their e-waste by exporting it to developing countries that often lack the necessary technology and capacity to properly recycle or refurbish such waste. Both OECD and non-OECD countries must outline in their legislation under which circumstances such transborder movements of e-waste are permitted.
- **Supervision of recycling standards.** Beyond the establishment of high environmental standards for e-waste treatment, legislation can outline the institutional support necessary to make more appropriate decisions regarding technological resources used for treatment. The creation of such a supervising agency would ensure continuous best practices as the nature of and scope of e-waste changes in the future.
- **Enforcement of the regulation.** Modalities for the enforcement of e-waste regulation must be outlined in the legislation, as some actors will actively circumvent regulatory obligations.

Best in class: the European Union's E-Waste Directive

As of the publication of this report, the most widely influential and replicated legislative framework for the management of e-waste is the European model.

The European e-waste market is strongly influenced by the EU Directive 2002/96/EC, the directive on e-waste and its national transpositions. The E-Waste Directive is based on the principle of Extended Producer Responsibility (EPR), which is a guiding principle of the European recycling strategy.

The EU does not impose the requirements of its directives directly on companies or consumers, but rather on its member states. It is the responsibility of the member states to implement policies to ensure compliance with EU Directives.

Scope and objectives

Virtually all classes of electrical and electronic equipment are addressed and covered by 10 categories of products, from private households and professionals.

Based on the premise of Extended Producer Responsibility and the fact that improved product design can unhinder recycling and disposal of end-of-life products, the key objectives of the E-Waste Directive are to:

- Reduce e-waste disposal to landfills.
- Improve product design with a view to both preventing e-waste and to increasing its recoverability, reusability and/or recyclability.
- Achieve targets for recovery, reuse and recycling of different classes of e-waste.
- Provide for the establishment of collection facilities and separate collection systems for e-waste from private households.
- Provide for the establishment and financing by producers of systems for the recovery and treatment of e-waste, including provisions for placing financial guarantees on new products placed on the market.

Financing

Producers are responsible for the costs of picking up waste electrical and electronic equipment from collection facilities and for refurbishing waste products for reuse or for recycling and recovery. For “historical” products (i.e., those put on the market before August 13, 2005), the costs of waste management are shared by all producers in existence at the time those costs were incurred. These producers may impose a separate “visible fee” to cover these costs for eight years (ten years for large household appliances). End users other than households may be made partly or totally responsible for financing the management of historical products. For new products (i.e., those put on the market after August 13, 2005), producers have “individual responsibility.” That is, they must pay the cost of managing their own products. They can do this through programs set up by individual companies or through participation in collective schemes.



Photo Credit: Mosman Council

Transborder movement of e-waste

Not covered in the E-Waste Directive but addressed in complementary legislation, the export of hazardous waste for recovery from the EU to non-OECD countries is prohibited, since these countries usually do not have proper and sufficient treatment capacity. The export of nonhazardous waste to non-OECD countries, has to be notified to the authorities in advance according to what each of the non-OECD countries has arranged with the EU (per Council Regulation (EEC) No 259/93).

Supervision and enforcement

In terms of supervision and to define best available technologies in a continuous process, the European Commission established the so-called Technical Adaptation Committee (TAC). Currently the E-Waste Directive is under revision after the first years of operational experience in the member states.

As per the enforcement of the E-Waste Directive, member states must establish a register of producers and collect annual information on the amounts of electrical and electronic equipment that are put on the market, collected, reused, recycled, and recovered. They must transmit this information to the EU Commission once every two years.

Shortcomings in the legislation

- **Discrepancies among European regulations.**⁶ The transposition of the E-Waste Directive into national law already reveals major differences from one legal system to another. The differences in implementation from one market to the next resulted in complexity for industry. Under the E-Waste Directive producers are required to follow the 27 national implementations of the E-Waste Directive. This may lead to different interpretations and implementations and it may result in a heavy administrative burden which will impact costs.
- **Lack of enforcement.** Per the E-Waste Directive, the EU can impose penalties on member states that fail to comply with its specifications. However, many recyclers complain that there is a lack of authoritative control enforcing the EU Directive. According to the EERA (Electrical Equipment Representatives Association), the enforcement is fragmented between many different authorities such as ministries and inspectorates, port and customs authorities. Furthermore, the European Union is not responsible for the enforcement of the E-Waste Directive, but rather the individual member states—and each country has its own enforcement schemes and interpretations. EERA has stated that enforce-

ment of the E-Waste Directive within the EU has proven ineffective for several reasons, including:

- ♦ The low prioritization of the directive.
- ♦ The lack of power and means for proper inspections.
- ♦ The absence of systematic cooperation of local authorities/actors.

Conclusion

With many developed countries having drafted and implemented e-waste regulation, emerging countries are more and more looking for best practices in order to create the most effective and adapted versions for their own nations. It is clear that having a regulatory framework regarding e-waste acts as a key driver in structuring and driving recycling activities which are not sufficiently profitable at present, by setting mandatory recycling targets or by supporting the establishment of financing schemes for e-waste collection and recycling.

Some keys to successful legislation, as outlined above, still have yet to be perfected, as can be seen with the case of enforcement. Enforcement of existing and future regulations on e-waste in emerging countries will constitute a challenge, as the informal sector will likely remain a major player on the market in the medium term, even with the adoption of new legislation. To counter this challenge, maximum efforts should be made to ensure that the necessary resources

for proper enforcement in emerging countries will be applied.

Creating multiple stakeholder involvement to facilitate sector transformation

Engaging all the stakeholders: key success factor to develop a national policy on e-waste

When an e-waste strategy or policy is conceived and adopted, many stakeholders are affected by it. For this strategy to be successfully implemented, it is necessary to make sure these different stakeholders are well informed about the process and are adhering to the decisions made. In order to guarantee the success of the process, their implication in all the stages of the decision making is crucial. Government, local institutions, producers, importers, retailers, refurbishers, recyclers, dismantlers, scavengers, NGOs, and academics will need to be involved so as to guarantee their support and benefit from their experience regarding the issue at stake.

One essential actor not to forget is the public. Although it cannot formally be included in the process, it is nevertheless important that its awareness be raised. In the case of e-waste management, the public is a crucial part of the collection and treatment phases. A population of well informed end-users



ensures the access to sufficient feedstock for recyclers, dismantlers and processors in general. Therefore, the consumers need to know where they can dispose of their used electronics and equipment, and why it is important that these products be sorted and treated.

If the inclusion of all stakeholders in the process guarantees its wide acceptance and its efficiency, there are some obstacles that must be taken into account. Having so many actors demands significant efforts to reach consensus on strategic issues, as the stakeholders involved often have diverging interests and objectives. Such a complex process involving many different parties can take many years to yield results.

This will have to be considered in the planning of the development and implementation of a national policy on e-waste.

The value of progressive recycling targets

Quantitative objectives are a key aspect of any successful regulatory framework for e-waste. Targets notably serve to:

- Push recycling actors into action and create momentum.
- Set expectations on the part of the government and express national e-waste management ambitions.
- Establish a performance barometer to analyze short, medium, and long-term outcomes.
- Incite closer management of strategies and programs.
- Increase political will and stakeholder accountability regarding e-waste management.

Furthermore, targets provide focus for the national e-waste strategy, and their ambition level drives decisions about coordination needs, legislative needs, funding and resource allocation, promotion needs, monitoring and evaluation, as well as research, development and knowledge transfers.

Unrealistic objectives prove counterproductive

When overly ambitious or unrealistic targets are set, not only will objectives most likely remain unmet, but political and stakeholder repercussions will result. It is thus of the utmost importance to set progressive and realistic recycling goals to accommodate the substantial change taking place in e-waste management. The

restructuring and organization of the e-waste infrastructure necessitates a certain level of leeway as it takes shape.

Formalizing the informal sector with the help of neutral parties

Large informal sectors are often prevalent in developing countries or emerging economies that lack enforced formal policy regarding e-waste collection and management, notably South Africa, China, and India, the latter of which maintains an informal sector presence in the e-waste market of 95%. Romania, a member of the EU since 2007, also harbors a significant informal e-waste sector; although the European E-Waste Directive was transposed and has been applied since 2005, the country still lacks regulation regarding the integration of the informal sector. Despite their key role in the e-waste management industry, informal actors notoriously handle this waste in an environmentally unsound manner (for example, manual dismantling of hazardous materials and open-air burning), all the while putting their health and safety at risk.

However, with the ever-increasing volumes of e-waste being produced or exported to these countries, and with the growing interest among government officials and legislative bodies, formal recycling actors are emerging to create viable business solutions using safer recycling technologies. It is essential that the informal sector be captured in this process, not only to reduce environmental and health risks (by modulating fees according to environmental practices, for example), but also as their participation is key to accessing large enough volumes of feedstock for recycling. Furthermore, the informal sector's participation would equally serve to drive down collection costs and allow for the creation of green jobs.

Capturing the informal sector is not an easy feat for numerous reasons:

- Informal actors are often individual entrepreneurs that operate to survive on a day-to-day basis, with little surplus available to make the investments necessary to "formalize."
- Large informal sectors are composed of sometimes thousands of diverse actors that never collectively

work together, making for a very “to each his own” approach. This also makes it difficult to identify and locate them.

- Government and private sector attempts to engage with informal sector actors have resulted in hostile reactions and a certain unwillingness to voluntarily change their mode of operation, as they fear that the private sector will steal their business.
- Scrap dealers and recyclers often pay better prices for e-waste collection as compared to formal recyclers, who are burdened with high overhead costs to meet environmental compliance requirements.

Thus, a comprehensive approach must be taken in order to establish a lasting and productive dialogue that will allow for the progressive integration of this largely untapped resource for e-waste feedstock and economic opportunity.

The value of associations: a neutral third-party actor

Using an intermediary association with a global perspective on best e-waste practices is ostensibly the best approach for ensuring success. Ideally, such an association should be trusted by all stakeholders and have solid footing in:

- The government, with sufficient knowledge of existing or future policy objectives
- The private sector, including manufacturers and already-identified private recyclers
- The informal sector, in order to best understand their expectations and interests

The main objective of such an association is to voice the different parties’ concerns, help them resolve their outstanding issues, and represent them at a national decision-making level.

Example of GTZ-ASEM, active in creating safe e-waste channels in India: pilot project in Bangalore

GTZ-ASEM is a joint program of the Indian Ministry of Environment & Forests (MoEF), the Government

of India, and GTZ (the German Gesellschaft für Technische Zusammenarbeit, an international cooperation enterprise for sustainable development).

A multi-stakeholder dialogue was created involving:

- GTZ-ASEM as an intermediary
- The international e-waste expert EMPA (Swiss Federal Institute for Materials Science and Technology)
- Local manufacturers, NGOs, and government bodies in Bangalore (represented by their joint association, the E-Waste Agency for E-Waste Management in Bangalore)
- Informal recyclers and collectors

GTZ-ASEM moderated initial tension and resistance on the part of the informal sector in order to create an open dialogue regarding regulation and policy, the need for awareness-raising in e-waste management, the organization of proper e-waste management practices by way of training sessions with informal sector actors and international experts, the uplifting and formalization of the informal sector through the creation of financial incentives on the private end, and the implementation of an efficient e-waste collection and channelization mechanism.

As a result of the GTZ-ASEM initiative, three informal sector organizations in Bangalore were created, a formal e-waste recycler (E-WaRDD) was established and trained with organizational and marketing skills, awareness campaigns were implemented on a municipal level, and capacity-building sessions were carried out. Furthermore, health and safety training sessions were conducted with experts from GTZ in Germany.

Given the success of the initiative, it is now being replicated in four other major cities throughout India. Other formal recyclers such as E-WaRDD are now emerging and progressively contributing to the organization of the sector.

Another positive result from this association’s work included GTZ-ASEM’s substantial contribution to the drafting of national e-waste legislation in India. Their role as a solid e-waste actor with a comprehensive understanding of financing, collection, stakeholder, and policy issues positioned them to offer concrete recommendations for advancing e-waste manage-



Photo Credit: Mosman Council

ment regulation. The drafted legislation was written to go into force in January 2012.

Nevertheless, the introduction of a neutral association into the multi-party dynamic was not without its own challenges. Several short-term challenges were identified including:

- GTZ-ASEM encountered initial distrust from government actors and formal recyclers, as it was thought that they were primarily representing the informal sector.
- Given the lack of national legislation regarding e-waste management in India, manufacturers lacked interest in taking on the responsibility of proper e-waste management.
- All parties were concerned about the loss of rare metals by exporting e-waste to other countries for end-process recycling or recovery.

The future will also hold specific long-term challenges, such as:

- The lack of national policy: A past experience with national policy integrating EPR principles for the take-back of car batteries failed, as little enforce-

ment accompanied the legislation. A proper implementation and enforcement strategy is thus key to the scheme's success.

- Insufficient awareness among individual consumers is a major blocking point for increasing the responsible disposal of e-waste.
- The integration of the informal sector will be progressive, and no quick solution exists.

The fruit of the GTZ-ASEM initiative and multi-stakeholder dialogue was a proposed new model for collecting and recycling e-waste.⁷ Under this new model, the informal sector associations collect, segregate, and dismantle e-waste in an environmentally sound manner, while the formal sector ensures resource extraction and recycling. The informal sector plays a critical role in collecting household e-waste in India and China. In some cases, the informal sector has already started to organize so as to operate in a more consistent way and also implement technologies that are more efficient and more environmentally friendly. This strategy is also aimed at obtaining recognition from authorities and switching to official operations, in compliance with existing regulation. Such initiatives are already occurring in various countries:

- **India.** E-WaRDD, a group of different informal actors, should soon become an authorized group by Indian authorities to operate as a formal recycler.
- **China.** Actions are currently planned in Guiyu so as to organize the collection by scavengers, with the support of a leading home appliance manufacturer (TCL).
- **Other emerging countries.** Among other stakeholders in the e-waste recycling business, EMPA has been involved in a “Knowledge Partnership with Developing and Transition Countries in Electronic Waste (e-waste) Recycling” project which aims to evaluate the feasibility for establishing more sustainable e-waste recycling systems in three selected regions: New Delhi in India, Beijing in China and Johannesburg-Pretoria in South Africa.
- Increase of compliance costs for informal recyclers should reduce the value of e-waste on the informal market, which could reinforce the competitive position of formal recyclers. In this respect, as the informal market currently captures more than 90% of e-waste available, there would be a tremendous growth potential for formal recyclers which would need financing so as to be able to develop their activity.
- Ban of informal recyclers (as unregistered actors). China and India are already starting to impose minimum recycling standards on such actors. In the future, unregistered actors may be banned or even prosecuted.
- Establishment of a financing system or take-back schemes.

Although the investment potential remains unclear, the IFC might identify opportunities to support projects from groups of informal recyclers wishing to shift to more professional processes (proper sorting plants, etc.). Alternatively, support needed for the progressive improvement of the informal sector might take the form of capacity-building support.

This evolution will be progressively supported in the medium term by the implementation of e-waste regulation in emerging countries, which will most likely codify informal recycling as illegal with potential fines. In order to be able to maintain their activity, informal actors may be willing to implement low-cost technologies so as to meet the required environmental standards and still keep their costs low. This would, for instance, correspond to the set-up of a small workshop with appropriate venting where employees would dismantle e-waste and then make money by sending the different outputs to copper smelters or precious metal refiners. In this scenario, the informal market would maintain its activity on collection and dismantling of e-waste, but would leave recycling to formal actors.

In addition, depending on its reach and degree of implementation, upcoming regulation could have the following effects on the markets in emerging countries:

These trends indicate that there could be significant opportunities in the next years:

- Supporting the transformation of informal recyclers in more professional market players.
- Helping formal recyclers to scale up their activity due to increased market share as a consequence of stronger constraints on the informal sector's operations.

In any case, the setting up of financing support schemes for e-waste collection and recycling, if it occurs, will strengthen these trends and reinforce the role of the formal sector.

Managing end-processing from afar: the case of precious metal refining

High variability of e-waste value

E-waste recycling outputs are composed of potentially reusable parts (obtained during the dismantling phases) and of the various materials entering the composition of the product. These materials can be broken down as such:

- Steel, plastics and glass obtained from recycling operations. Prices of these outputs are highly dependent on available demand for steel, plastic and glass from end-of-life products. Demand has been very

strong for steel (scrap metal), but is sharply decreasing for CRT glass, as numbers of manufactured CRT monitors are declining. Plastics can represent a high potential in the future, if the oil prices and environmental concerns lead to increasing the share of recycled plastics used in products manufacturing.

- Recovered ferrous and non-ferrous metals which will be traded on the basis of commodity markets. These secondary raw materials (materials that are not recovered through recycling operations) are exchanged on the basis of prices of primary raw materials.

As seen in the table below, printed circuit boards and non-ferrous metals often found in IT and communication equipment are of particularly high value.

Less attractive recovery costs for emerging countries

Much disparity exists, however, in the methods used for recovery of precious metals, as there are only four

large integrated smelters/refineries worldwide. Three of them are in Europe:

- Umicore in Hoboken (Belgium)
- Norddeutsche Affinerie in Hamburg (Germany)
- Boliden in Rönnskär (Sweden)

In each case, e-waste is not the only input, and typically enters the process as a side stream: Boliden and Norddeutsche Affinerie are copper smelters and refiners with e-waste being a significant, but minor part of their business. Umicore as a precious metal smelter and refinery is specialized in precious metal-containing wastes in general. The very limited number of such facilities globally is due to the fact that economic operation is only feasible with a large-scale plant and with significant investments in processing technologies and pollution prevention.

For developing countries where best technologies regarding metal recovery are quasi-inexistent, toxic chemicals are often used to recover these valuable

Value overview of the main materials recycled/recovered

Material contents	Value	Characteristics
Ferrous metals	Average	High amount in e-waste collected.
Non-ferrous metals	High	Non-ferrous metals, including precious metals, even in small quantities, have a net positive value after recycling. Content of precious metals is decreasing in modern appliances.
Glass	High → Low	Mainly in CRTs. As CRTs are being replaced by flat screens (LCD and plasma technologies) in Western countries, reusing glass so as to manufacture new CRT televisions & monitors will soon be impossible. New outlets have to be found.
Plastics	Low	Plastics represent almost 25% of small household appliances. Plastic is very difficult to sort and requires expensive processes. New technologies are in development.
Printed circuit boards	High	PCBs contain various valuable metals (lead, copper, gold, silver, etc.). Quality discrepancies of PCB entail inconsistent quantity of metal content.
Reused components (other)	Average	Compressors, electric motors, integrated circuits (ICs), processors, hard drives, supplies from computers, etc.

metals, causing a direct negative impact to workers' health and to the environment.

In the absence of a regulatory framework for EPR standards and proper financing mechanisms for collection and treatment, one then asks what viable solutions exist for emerging countries looking to extract as much value as possible from these e-waste materials.

A model for emerging economies: export to the experts

As the processing costs for precious metal recovery are relatively high, there is no guarantee that costs incurred on the whole value chain will be covered (regarding collection, transportation, and treatment). Generally speaking, the market is not mature enough for complex treatments which require high volumes and are very capital intensive. Fully high-tech cutting-edge technologies are thus not necessarily the most adapted solution for emerging countries, either from an economic or environmental perspective. For this reason, one viable option is for local industrial initiatives to focus on collection, segregation, crushing and disassembly, while sending outputs to Europe for end-processing and complex treatment (especially refining for PCBs).

Example: "Best of 2 Worlds" project in China

The "Best of 2 Worlds" (otherwise referred to as Bo2W) is a project piloted under the Taskforce 4 Recycling of the United Nations University StEP initiative (Solving the E-waste Problem).⁸ The main objective of Bo2W is to use the best practices in e-waste management from Europe, while adapting the process according to the local climate and context in China. The end goal, since its debut in 2005, is the creation of a large-scale ICT recycling facility appropriate for the Chinese market.

The model for the project involves the eco-efficiency of manual dismantling of domestic e-waste in China with control over all environmentally relevant fractions. This was done by setting up a plant in Taizhou and creating a partnership with Umicore (Belgium).⁹ Waste is treated as such:

- Simple components from the sorted waste are recycled locally (dismantling, sorting), following strict health and safety standards.

- Complex parts such as parts containing precious metals, which cannot be processed efficiently in China, are sent overseas.
- Precious metals, like gold and silver extracted from circuit boards, are then either purchased by the recycler or returned to China.

In theory, by processing precious metals abroad in an integrated smelter/refinery, and due to higher recovery rates, a higher purchasing price can be offered to collectors/workers in the informal sector for unprocessed e-waste than the revenue that informal recyclers would generate by processing e-waste themselves. As China is in urgent need of resources for its economy, shipping back the metals would allow for a sound e-waste processing without creating a "metal drain" by sending them abroad.

Results of the project have shown that intensive dismantling involves lower system costs and higher material revenue, with the benefit of reduced environmental impacts, as compared to the initial scenario of conducting shredding in China. Using a combination of strict EHS standards in recycling facilities, the local dismantling of e-waste to separate diverse material and components, and end-processing abroad has proven to be a successful approach towards achieving high environmental and economic outcomes.

Challenges for the future

Countries such as China, South Africa, India, and Brazil feature large volumes of e-waste and a high-level of interest in recycling by the informal and the formal sector, which creates several opportunities for technology transfers, particularly regarding practices in pre-processing.¹⁰

While such well established systems exist, several challenges and barriers remain for this model, among which:

- Because informal actors usually operate on a rather small scale in terms of feedstock, and integrated smelters and refineries operate on a large scale, this model might necessitate a 'buffer' to connect and coordinate these smaller flows into larger batches. Such an intermediary should have the financial capacity to pay the informal units for the small amounts collected, and to wait for the payback.

For it can take several months for the material to be transported to Europe, analyzed, and processed.

- The Basel Convention requires an authorization from both exporting and importing countries,

before e-waste may be shipped internationally. Such 'notification procedures' are common practice, but require some administrative work for the exporting party.





Appendix 2

EXTENDED INTERNATIONAL CASE STUDIES

Extended international case study 1: India

Legal framework

Draft national legislation, in the form of the E-Waste (Management and Handling) Rules 2010, was drafted in March 2010. It is unclear when it will be voted into law, and whether amendments will be made before ratification.

Scope

Per the current draft of the E-Waste Rules 2010, e-waste is defined as “waste electrical and electronic equipment, whole or in part included in, but not confined to equipment listed in schedule-I and scraps or rejects from their manufacturing process, which is intended to be discarded.” The rules outlined in the drafted document apply to “every producer(s), dealer(s), collection centre(s), refurbisher(s), dismantler(s), recycler(s), auctioneer(s) consumer(s) or bulk consumer(s) involved in the manufacture, sale, purchase and processing of electrical and electronic equipment or components as specified in schedule-I.”

Key principles

First-time producers are responsible for the entire life cycle of the product, from the design to waste. If ratified, the rules will:

- Emphasize Extended Producer Responsibility, namely manufacturers and vendors, including financial responsibility and extending beyond the scope equipment sales in order to set up effective collection systems for the proper management and handling of e-waste.
- Define and include stakeholders in the scope of e-waste responsibilities, whether they be dealers, refurbishers, dismantlers, collectors, recyclers, or government agencies, for implementation and monitoring.
- Ban the import of used electrical and electronic equipment for charity in the country.
- Advocate “Restrictions on Hazardous Substances” and the need to restrict such substances in electronic equipment.

Until this rule set is ratified, however, the principal law generally applicable to e-waste is the Hazardous Waste Management Rules, 2003, as some e-waste or its components are considered hazardous. This text defines hazardous waste as “any waste which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances.” The Hazardous Waste Management Rules include three schedules:



- **Schedule 1.** Although there is no direct reference to electronic waste in Schedule 1 (which defines hazardous waste generated through different industrial processes), the e-waste processing could potentially be characterized as hazardous processes, which automatically qualifies the waste product as hazardous, regardless of its concentrations of different potentially hazardous materials.
- **Schedule 2.** This schedule lists waste substances that should be considered hazardous unless their concentration is below limit values set in the same Schedule. The various classes of substances listed in this Schedule are covered in Class A, B, C, D and E. E-waste and/or its fractions feature only under Class A and B and are given below:
 - ♦ Class A (concentration limits ≥ 50 mg/kg): antimony and antimony compounds, beryllium and beryllium compounds, cadmium and cadmium compounds, chromium (VI) compounds, mercury and mercury compounds, halogenated compounds of aromatic rings (e.g. polychlorinated biphenyls, polychloroteriphenyls, and their derivatives), halogenated aromatic compounds.

- ♦ Class B (concentration limits $\geq 5,000$ mg/kg): cobalt compounds, copper compounds, lead and lead compounds, nickel compounds, inorganic tin compounds, vanadium compounds, tungsten compounds, silver compounds, halogenated aliphatic compounds, phenol and phenolic compounds, chlorine, bromine.
- **Schedule 3.** Hazardous waste authorized for imports and exports is listed in Schedule 3. Export and import of items listed are permitted only as raw materials for recycling or reuse. Are notably considered as hazardous waste (if not reused):
 - ♦ A1180 glass from cathode ray tubes and other activated glass and PCB capacitors, or contaminated with schedule 2 constituents (e.g. cadmium, mercury, lead, polychlorinated biphenyl).
 - ♦ A1150 precious metal ash from incineration of PCBs not included on list 'B'.
 - ♦ A2010 glass waste from cathode ray tubes and other activated glass.
 - ♦ A3180 wastes, substances, and articles containing, consisting of or contaminated with polychlorinated biphenyls (PCB) and including any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more.

For now, the Hazardous Waste Management Rules, 2003 are not enforced for e-waste recycling, which is explicitly covered by the regulation.

Policy and organization

The lack of formal policy in India regarding e-waste is a hindrance to the organization of the collection and recycling process. Collection and recycling in India is almost totally performed by the informal sector. Although a formal, organized e-waste recycling industry is emerging in India, it is estimated that 95% of total e-waste generated in India is captured by the informal sector. Informal collection and recycling take place in residential areas, are carried out without licenses, and involve large quantities of material. E-waste is usually treated manually in order to dismantle and recover precious metals. Groups of informal recyclers like E-WaRDD are now emerging and progressively contributing to the organization of the sector.



Until the draft E-Waste (Management & Handling) Rules 2010 are ratified, there is no national ban on importing e-waste.

Market structure

For the major e-waste stakeholders, see the table below.

Access to feedstock

The formalization and organization of the informal sector is a crucial element in ensuring constant e-waste flows for collection and treatment. One formal treatment actor with five facilities in India (Earth Sense) has said the viability of its business depends on this

Institutional stakeholders	<p>Policymakers and regulatory authorities: organizations which are in charge of defining and implementing environmental regulations, including:</p> <ul style="list-style-type: none">• Ministry of Environment and Forests (MoEF).• Government agencies (Pollution Control Boards) with specific responsibility for enforcement of environmental rules and legislation. For example, the Central Pollution Control Board (CPCB) at the national level and the Maharashtra Pollution Control Board (MPCB) and the Karnataka State Pollution Control Board (KSPCB) at the regional level. <p>Lobbying Groups and NGOs: NGOs like Toxics Link, Saahas etc. are working significantly on e-waste management initiatives in different parts of the country in association with donor agencies and IT companies and industry associations.</p> <p>Industry associations that reflect on e-waste management in India and take part of the different existing workshops and initiatives on the topic. Examples include:</p> <ul style="list-style-type: none">• National Association of Software and Services Companies (NASSCOM): India's premier trade body and the chamber of commerce of the IT software and services industry.• Manufacturers' Association for Information Technology (MAIT): this association was set up in 1982 for the purpose of scientific, educational and IT industry promotion. Its aim is to promote the usage of IT in India, and to contribute to the development of a globally competitive Indian IT industry.
E-waste generators	<p>This group includes manufacturers of electrical and electronics appliances/components.</p> <p>EEE producers generate e-waste during their processes. E-waste is also generated from Small and Medium-sized Enterprises (SMEs) that manufacture components. These SMEs act as suppliers to the large multinationals. Large IT manufacturing companies can be involved in the formal recycling sector by contracting with formal actors.</p> <p>Furthermore, major IT producers such as HP, WIPRO, and HCL play a key role by offering to their customers (B2B and B2C as well) a take-back system and by securing a flow of e-waste for authorized recyclers:</p> <ul style="list-style-type: none">• WIPRO: The service allows customers to return old PCs to Wipro for recycling on payment of the applicable freight charge. The company has set up partnerships with three authorized recyclers—Ash Recyclers and e-Parisaraa in Bangalore and Trishyiraya in Chennai.• Hewlett-Packard: The HP Planet Partners Hardware Return and Recycling Program offers to take back end-of-life HP computer and printing hardware products. This initiative offers customers an option to dispose of and recycle used computing equipment in a socially and environmentally responsible manner.

(continued)

	<ul style="list-style-type: none"> India's largest hardware manufacturer, HCL Infosystems, has initiated a take-back process offer for its customers' end-of-life products to be recycled. HCL has a comprehensive policy on environment management processes to ensure protection of the environment, health, and safety of all its stakeholders. <p>However, these experiences have not been very successful so far. Currently only a few of their large customers use the service. The rest simply prefer to sell the equipment as scrap to the informal sector.</p>
Consumers/ users	<p>Business (including both large companies and SMEs): most large companies have introduced e-waste management systems (identification, segregation and disposal of e-waste), while SMEs do not have internal environmental guidelines and sell their e-waste to the informal sector.</p> <p>Households: e-waste from households is estimated to be in most cases kept at home, transmitted to relatives, or in some cases given back to relatives when purchasing new products, but is seldom transferred to e-waste collectors.</p>
Informal and formal recyclers	<p>While 90% of recycling takes place in the informal sector, there is an emerging formal sector, comprised of several notable actors, including Attero, AER Worldwide, Ash Recyclers, E-Parisaraa, E-WarDD, InfoTrek, Syscom, Ramzy/Cimelia, Trishyiraya, ULTrust Solutions, and Waste re-Energy.</p>

transformation of the informal sector. Low collection rates are an issue for formal actors.

Insight

One of the most pressing issues for e-waste management success is the integration of the informal sector. In India, members of the extensive informal network have taken steps towards organizing their activities by creating "informal actor associations" (ex. E-WaRDD). The presence of such associations seems to have facilitated the relationship between formal and informal actors. A neutral agency (GTZ-ASEM) supporting the government's priorities as well as the informal sector has eased previously hostile reactions on the part of various actors.

However, stakeholders, although optimistic about the development of the e-waste management market, express concerns that unenforced legislation will hinder the market. Financial incentives for informal collectors and individual consumers returning their e-waste emerged as a recurring theme during stakeholder interviews.

Focus on good practice: implementing a clean e-waste channel in Bangalore's Electronics City

The Electronics City Industries' Association (ELCIA) in Bangalore recognized the need for a central e-waste collection point in Electronics City and took the initiative to implement a project that is unique in India. It is planned to facilitate collection, disposal and transportation of e-waste generated in Electronics City. Companies and their employees will have the option to deliver their corporate and domestic e-waste without paying a disposal fee. ELCIA will inform the companies of the collection point in detail before starting the operation. ELCIA will dispose of the collected e-waste to an authorized recycler and ensure that the recycler complies with all applicable legislation and ELCIA's best-practice standards. The companies are responsible for ensuring that they have complied with all applicable legislation and regulatory requirements.

E-Parisaraa

E-Parisaraa began operation in Bangalore in September 2005. E-Parisaraa was the one of the first autho-

ized e-waste recyclers in Bangalore, with customers including HP, IBM, GE, Intel, Motorola and Honeywell. It focuses on computers from companies, and has secured contracts to purchase e-waste at a price of about €140 to €175 a ton. E-Parisaraa acquired an export license and sends e-waste to Umicore Precious Metals Refining in Belgium (all precious metals except gold, which is processed in one of E-Parisaraa's smelters).

E-Parisaraa is expanding quickly. In 2008, it started a joint venture with G.J.Multiclave Pvt. Ltd., pioneers in biomedical waste management, under the name of Earth Sense Recycle Pvt. Ltd. in Delhi (Manesar), Hyderabad, Bombay and Chennai. E-Parisaraa also plans to develop recycling facilities in Kolkatta, Pune,

Indore, Trivandrum and Jaipur, as well as collection centers in major cities.

Extended international case study 2: South Africa

Legislation

Solid waste—both hazardous and non-hazardous—is regulated by several acts, especially:

- Consumer Protection Act, 2009
- National Environmental Management: Waste Act, 2009

Strengths and weaknesses of the Indian approach to e-waste

Strengths	Weaknesses
A considerably open dialogue among relevant stakeholders (NGOs, government agencies, producers, recyclers, collectors) that helps the government to move quickly to define India's e-waste strategy.	The drafted legislation does not outline collection and treatment schemes, nor does it provide incentives (financial) for the involvement of the informal sector.
Some voluntary take-back initiatives are already underway (Nokia's, for example).	Past environmental legislation has been poorly enforced, and if reproduced for e-waste legislation, the movement for proper e-waste management will be threatened.
Awareness-raising campaigns in the community often accompany formal recycling activities, although not always on a large scale.	There are very few formal e-waste treatment centers. Technology and facilities already exist, but more need to be developed to handle the potentially large volumes of collected waste.
National e-waste legislation can act as a potentially strong driver for proper e-waste management.	Insufficient awareness-raising measures to date have e-waste stakeholders and notably consumers in the dark about the importance of the issue.
A successful initiative to integrate the informal sector in Bangalore is serving as a model to be reproduced in other Indian cities.	Licensing guidelines for treatment facilities are not yet streamlined by the Central Pollution Control Board.
Awareness-raising by public and private actors could serve to increase consumer knowledge about e-waste and increase collection rates.	

- Environmental Conservation Act, 2008
- National Environment Management Act, 1998

Policy and organization

Environment legislation is still recent, especially regarding e-waste management. Forums are being held by SA environmental officials to explain the implementation of the Waste Act of 2009. Breakdown of roles is not precisely defined between manufacturers, retailers, consumers and municipalities. One of the essential elements of the Waste Act is that manufacturers and importers must define an Industrial Waste Management Plan (IWMP) before selling products in South Africa (in principle, this is equivalent to an EPR). The role of retailers is not defined. This obligation is not mandatory. No specific legislation was passed to enforce a specific financial scheme such as EPR.

Market structure

E-waste flow is estimated at 100,000 and 400,000 tons per year. The informal sector does not focus on e-waste for valuable materials as it is considered too complicated, with the exception of cables and CRT copper coils.

Some of the main producers and importers of e-products in South Africa created the e-Waste Association of South Africa (eWASA) for IWMP implementation and lobbying actions. Its operational and financial design is still ongoing.

In Cape Town, five e-waste recycling or refurbishing companies were identified. They are small-scale, relatively young companies. They created an alternate association for e-waste recycling called E-Waste Alliance, as they believe eWASA does not properly address the issues at stake. A larger e-waste recycling company, Desco, has been operating in Johannesburg for 15 years and works regularly with eWASA members.

Access to feedstock

Various collection and treatment initiatives were identified in SA. Small Capetown recycling companies get most of their incoming waste from businesses. Bigger businesses often issue tenders to sell their e-waste to recycling companies that then make a profit out of the recycled products.

Cooperation with the informal sector also takes place. In this case a small reward is given to scavengers to bring e-waste to recycling companies.

Lessons

The legal framework is encouraging, even if some elements such as finance and collection might benefit from further refinement. eWASA (a similar organization to the European eco-organisms) is considering an Advanced Recycling Fee (ARF)—where advanced means “in advance”—to provide a sustainable source of funding. EnviroSense, a consulting agency for environmental management, says the ARF should be used to develop capacity, i.e. to cover capital expenditures as well as operating ones.

Second-hand e-products sent to SA (and to many other African countries) constitute a serious issue as many of them are actually e-waste that requires treatment and cannot be used as second-hand products. Mandatory IWMPs constitute a base for an effective EPR, but this process does not ensure the required level of governmental control and consistency of operations. For example, types of waste that have to be dealt with in priority by the IWMPs are not defined.

Social issues should be kept in mind when considering technological solutions. “Screwdriver operations” might be relevant where unemployment is high and qualification is low. Interviewees indicate that all the governmental funding seems to go now to eWASA, which does not target funding of SMEs and NGOs.

Focus on good practice: eWASA

eWASA activities include:

- Management of e-waste recycling systems on behalf of industry.
- Management of green/ARF funds, data clearance and controlling.
- Quality control through independent technical experts and auditors.
- Public relations.

eWASA key stakeholders are:

- Importers and manufacturers of:
 - ♦ White goods and consumer electronics

- ♦ ICT
- ♦ Lamps
- ♦ Batteries
- Distributors of:
 - ♦ White goods, consumer electronics and ICT
 - ♦ Other IT, LHA, SMA & CE retailers
 - ♦ IT, mobile, and telecoms
- NGOs and academic institutions, financial institutions, parastatals
- Collectors, transporters, dismantlers, refurbishers, recyclers
- Rental solutions, consumables i.e. printer cartridges, refineries, automotive
- Waste 2 Art (a company that sells art craft based on re-used waste)

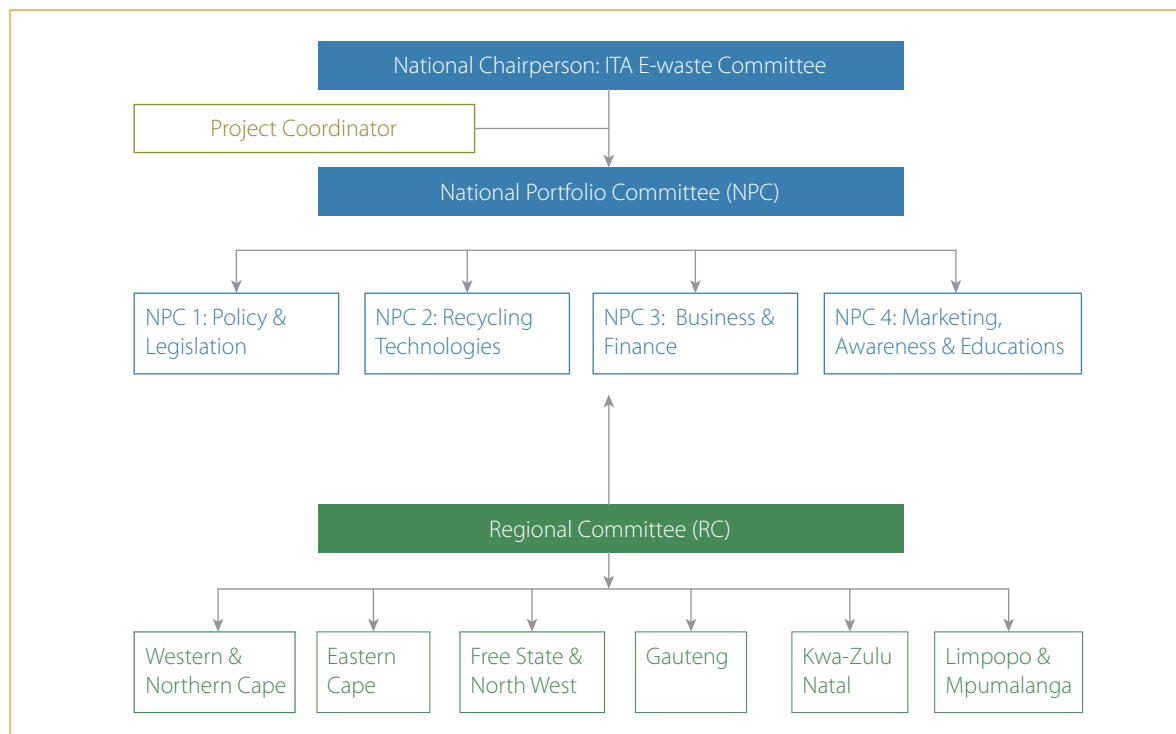
Activities for 2011

- Formal launch of “National Take Back Scheme”
- Formal launch of green/ARF fee structure
- Media campaign on Education, Awareness, “Name & Shame”
- Membership drive
- “Carbon Footprint” Schools Project
- Establishment of an Africa e-waste forum

The eWASA Recycling Guarantee Ensures that:

- The collection points are at most 40 km from the recycling companies.
- The 1,000 created jobs are given to the most underprivileged members of society.

Organization



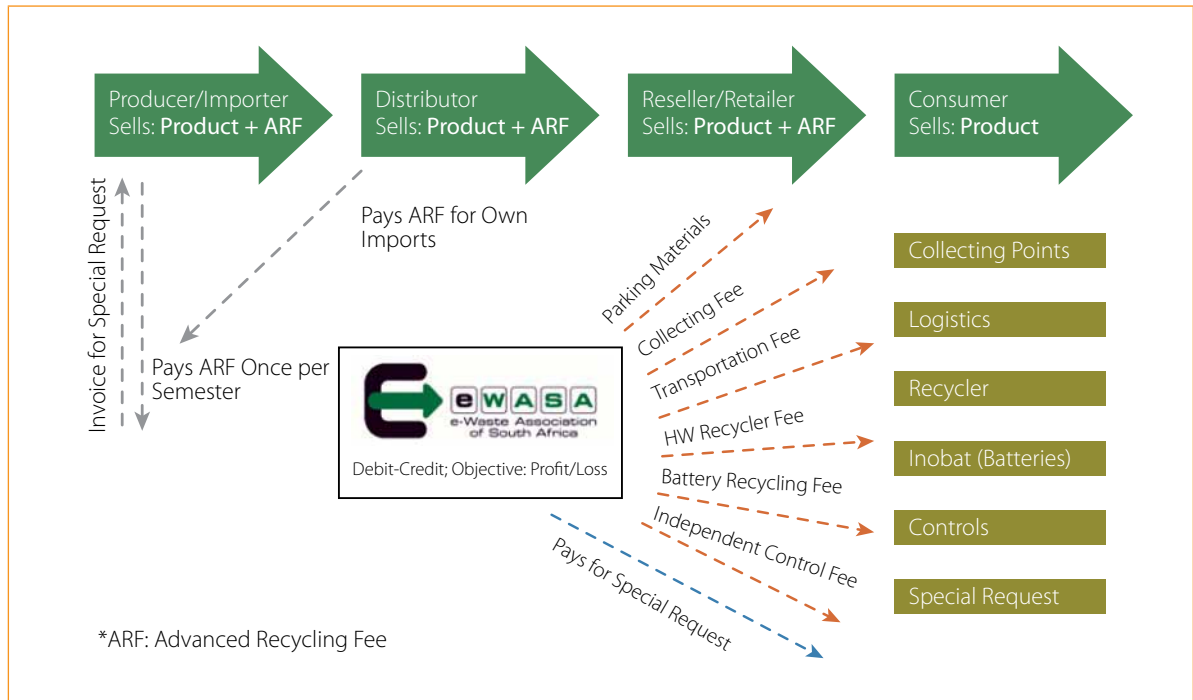
Source: eWASA

eWASA take-back scheme



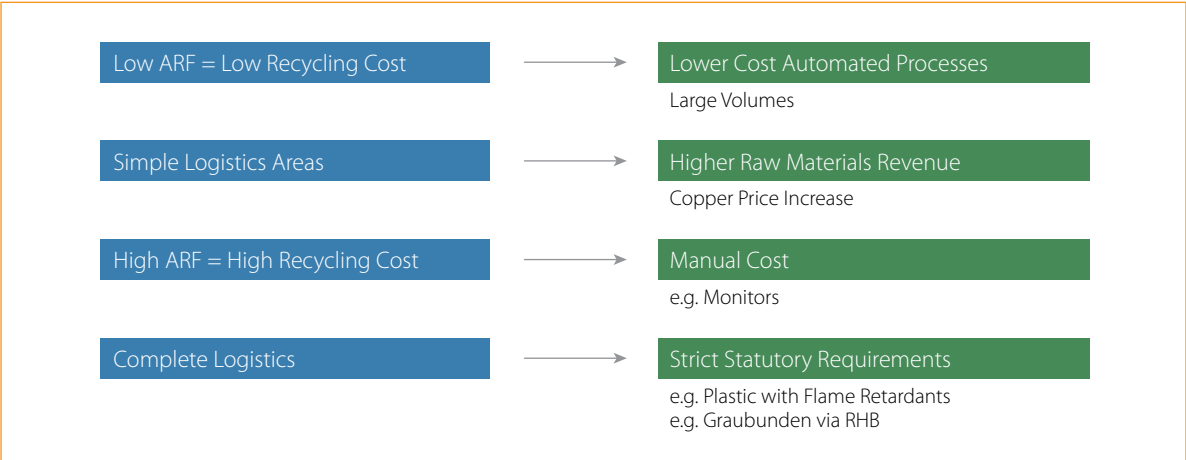
Source: eWASA

ARF/green fee financial flow



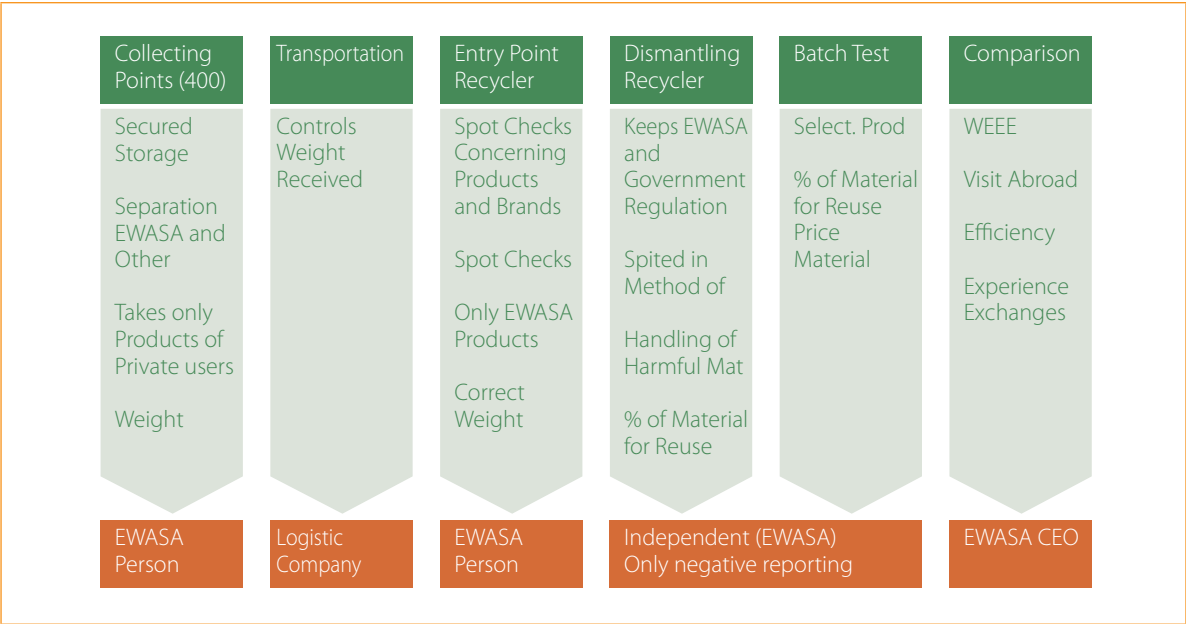
Source: eWASA

Specifying the ARF tariff according to cost



Source: eWASA

Controls



Source: eWASA

E-waste legislation development and timeline in SA

The Waste Act of 2009 has progressed according to the following list of events:

- Hazardous waste categorization & classification
- Classification of priority waste
- Lighting industry requested to submit integrated industry waste management plan
- Industry Waste Management Plan (IWMP) for e-waste has been drafted by eWASA and is currently under review by stakeholders

Key development issues

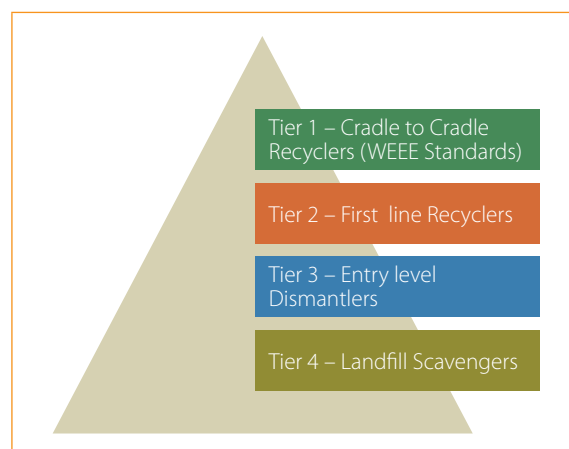
The following have been centerpiece features of the South African strategy on e-waste:

- National Take-Back Scheme (TBS)
- Education and training
- Awareness campaign

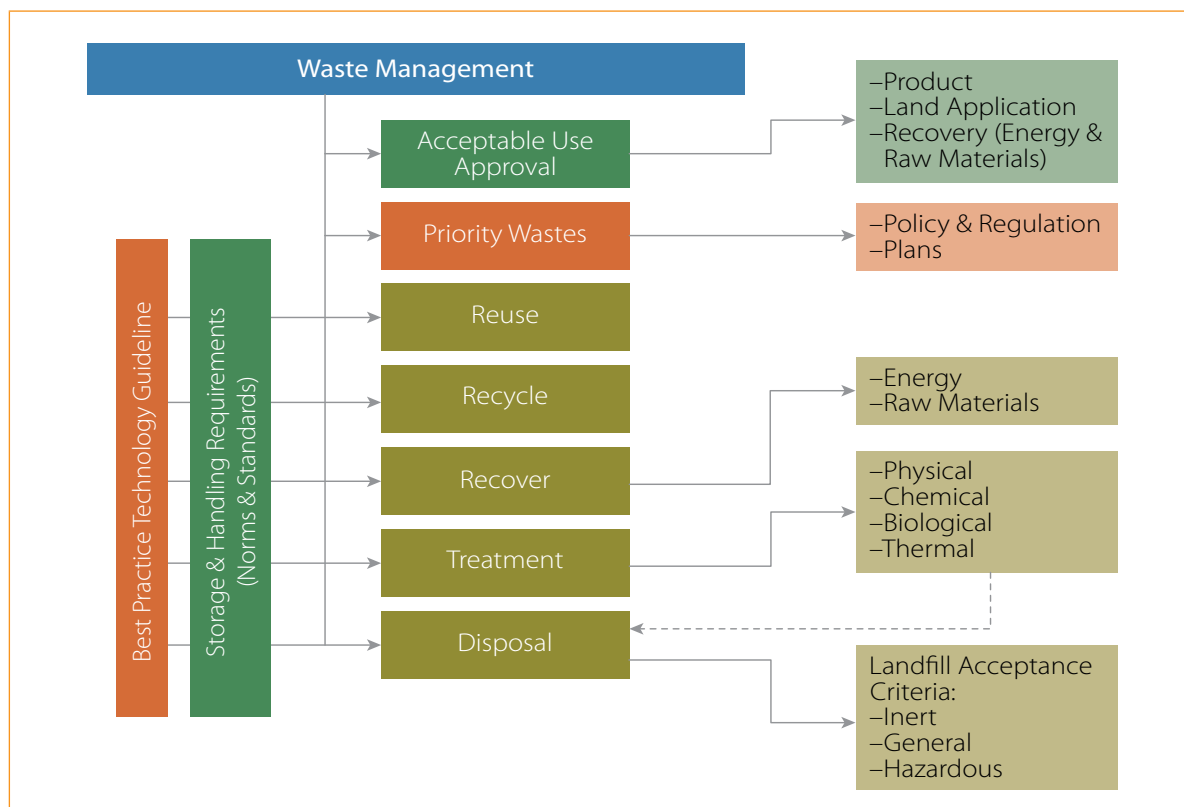
Extended international case study 3: Costa Rica

The issue of e-waste management in Costa Rica is similar to that of other countries in Latin America. Primarily, the problem identified was the lack of effec-

Predicted structure of the recycling industry



Waste Act



tive mechanisms allowing consumers (the general public as well as companies) to return electronic equipment for appropriate treatment at the end-of-life stage. Before developing regulation, a diagnosis of the e-waste management situation in Costa Rica was completed¹¹. Although it was made in 2003, and concerns only some districts of the country, it gives a general understanding of the national situation.

Before the national law was implemented, small businesses collecting solid waste also collected e-waste from companies, shops and repair shops and transported all the waste to treatment plants, illegal dumps or final disposal sites. There was no separation in collection, and recycling was scarcely done, with only a few small “collection centers” recovering

recyclable materials, as well as a small informal sector composed of “buzos” collecting materials from the street or from final disposal sites. Some attempts have now been made at formalizing the informal sector, with for example the founding of the *Asociación de Recuperadores de Tirrases*, regrouping 76 persons from the informal sector, 10 of whom specialized in the recovery of electronic equipment, thanks to basic classes of electronics.

In May 2010, Costa Rica’s Ministry of Health and Ministry of Environment, Energy and Telecommunications approved a comprehensive producer responsibility regulation for electronic products. The *Reglamento para la Gestión Integral de Residuos Electrónicos* (Regulation for the comprehensive Manage-

Strengths and weaknesses of the South African approach

Strengths	Weaknesses
A financial and operational support from Swiss EMPA enabled launching and developing actions regarding e-waste management in Cape Town. A pilot was launched under the collaboration of small recyclers and bigger producers.	The existing legislation is not precise enough on the fiscal and financial scheme and on the breakdown of responsibilities between companies and public bodies. This may hinder the development of a large-scale e-waste management scheme. Furthermore, the law is not coercive, which may not foster speeding up the process.
Existing legislation makes the definition of an IWMP compulsory for producers and importers. Those actually develop IWMPs through a non-profit company eWASA.	There is no large-scale solution for the treatment of e-waste in South Africa. Regulation exists but collection is not organized, which makes it difficult for small businesses to reach a financial balance and for bigger recyclers to develop at the national level.
The Consumer Protection Act forces retailers to accept take-back from consumers buying a new product.	In some cases, small recycling companies and bigger producers have not found a compromise yet between financial capacities of the first and environmental policies requirements of the latter.
Scavengers are more and more kept out of landfills, which makes it easier to develop recycling businesses. They may then collaborate in the collection process.	The development of IWMPs is deemed too slow by some of the non-eWASA actors.
There are High Hazardous Waste Landfills that provide a solution for the management of some non-recyclable elements.	There are not enough downstream industrial users of recycled waste to enable the management of all by-products.
EPR is already actually enforced for plastic bags and tires.	

ment of Electronic Waste, or 35933-S regulation) establishes, among other things, the principles for the Extended Producer Responsibility (EPR): it holds the manufacturers, importers and merchants of listed electronic equipment responsible for collecting and managing their end-of-life products, either individually or collectively, through registered “Compliance Entities”, required to present compliance plans, meet benchmarking targets, and undertake reporting and public awareness activities.

Scope

The Executive Decree considers as e-waste all the electronic equipment listed:

- Laptop and desktop computers (including accessories).
- Batteries: laptop computers, cell phones and uninterruptible power supply units (UPS)
- Chargers
- Scanners
- Cell phones
- Printers
- Photocopiers
- Digital cameras
- Portable digital assistant (PDA)
- Multifunctional office equipment (printer, copier and fax)
- Calculators
- Overhead projectors
- Slide projectors
- Internet routers: wired and wireless
- Media players

Monitoring and verification obligations

In order to monitor actions on the ground, the regulation also establishes:

- A National System for the comprehensive management of electronic waste, SINAGIRE (Sistema Nacional para la Gestión Integral de los Residuos Electrónicos);
- An Executive Committee, CEGIRE (Comité Ejecutivo para la Gestión Integral de los Residuos Electrónicos), that will oversee the operational

implementation of SINAGIRE thanks to the participation of various stakeholders.

Role and responsibilities of the Compliance Units

To address the lack of organization in the e-waste market, compliance units were set up to ensure a comprehensive e-waste management scheme. The Executive Decree requires producers and/or importers of electronic equipment to register with the Compliance Unit in order to be allowed to deal in electronic equipment.

A Compliance Unit is composed of one or more producers, importers and/or distributors of electronic equipment to demonstrate compliance with the regulation before the Executive Committee (CEGIRE). The Compliance Units are intended to be the channel for the proper treatment of electronic waste.

The responsibilities of a Compliance Unit include:

- Register with the Ministry of Health.
- Present and implement a compliance plan. The units are required to establish a set of programs and specific actions through the various stages of production, marketing and management of equipment generating electronic waste. The Plan has to meet the performance indicators set by the Ministry.
- Develop required activities to comply with the regulation.
- Achieve the recycling goals established by the CEGIRE.
- Guarantee the traceability of electronic parts and equipment that are regulated (since May 5, 2010) for further environmental treatment.
- Design and implement the mechanism to guarantee the sustainability of collecting and treatment processes.
- Establish collecting points for all actors of the value chain.

To date, only one Compliance Unit has registered through the Ministry of Health. ASEGIRE (Asociación de Empresarios para la Gestión de Residuos Electrónicos) was founded in 2009 at the initiative of several producers and in anticipation of the regulation to come. Between June and October 2010, ASEGIRE treated 8,000 kg of e-waste through authorized agen-

cies, i.e. recycling companies complying with the national and international law (Basel Convention). ASEGIRE also provides training services, technical and legal assistance for its members, helping them to implement effective e-waste management systems.

Focus on formalizing a national policy for e-waste: creation of a multi-stakeholder work group in Costa Rica

Since 2002, Costa Rica has participated in a bilateral cooperation agreement for sustainable development with Holland. This partnership has led to the collaboration between 2003 and 2007 of the Central American Association for Economics, Health and Environment (ACEPESA) and the Dutch association WASTE Advisers on urban environment and development.

A working group was started which included the private sector (Chamber of Industry, American Cham-

ber of Commerce and various private companies), the academic sector (Instituto Tecnológico de Costa Rica, Centro Nacional de Producción más Limpia) and government representatives from various ministries.

- They did a technical, financial, environmental and legal analysis of e-waste management in Costa Rica.
- Based on this, they developed the Sustainable Strategy to Minimize and Manage Electronic Component Waste in Costa Rica. The working group traveled to Holland so as to study Dutch companies' best practices on site, and integrated their findings into the strategy.
- The working group then launched e-waste collection campaigns in Costa Rica, earning significant press coverage throughout the country and engaging the public.

Strengths and weaknesses of the Costa Rican approach

Strengths	Weaknesses
Study of Costa Rica's situation regarding e-waste prior to the drafting and launching of a legislation.	Difficulty to access and compile information in a country where there is very little available data and no follow-up of e-waste.
The project and its outcomes (National Strategy and Executive Committee established by law) benefited from the study of Holland's best practices and from a visit of the Technical Committee on site.	Having so many actors demands great efforts to reach consensus on strategic issues.
Identification of the key actors and stakeholders for an efficient national e-waste management.	Delays in the implementation of the project because of the absence of clarity of competencies on e-waste at the state level.
Inclusive process with the participation of NGOs, private sector companies, government agencies and the academic sector in a National Technical Committee that oversaw the entire process.	
Establishment of an Executive Committee that will oversee the operational implementation of the national strategy for e-waste.	
EPR is already actually enforced for plastic bags and tires.	

- The work done by the group led to the adoption of the national regulation on e-waste in 2010.

Results

The campaign raised awareness among the public and helped put the subject on the national agenda, by urging the government to take action. The inclusiveness of the process extended from the development phase to the implementation phase of the law.

The in-depth work of the group led to the adoption of:

- The Waste Management Law that introduced the Extended Producer Responsibility for the first time in Costa Rican law.
- The Regulation for the comprehensive management of electronic waste, which establishes, among other

things, a registry for waste movements, as well as monitoring and verification obligations.

To monitor compliance, the regulation established an Executive Committee, CEGIRE (Comité Ejecutivo para la Gestión Integral de los Residuos Electrónicos), to oversee the operational implementation of the national strategy for e-waste, with the involvement of various stakeholders.

This experience can be used in other environmental issues where many different stakeholders are concerned. It creates capacity within the country to answer such problems in a coordinated and efficient manner.

ENDNOTES

¹ J. Huisman, UNU – ISP SCYCLE, STEP ADDRESS Worldwide EEE and WEEE estimates, update 31-01-2011, Bonn Germany.

² According with the publication *Varejo em Detalhes*—NE&PR/GS&MD—Gouvea de Souza, 2010.

³ IDC Financial Insights in partnership with Bank Technology News - USA.

⁴ Lucio Di Domenico, DescarteCerto shareholder.

⁵ SUR Corporation on Social Studies and Education, Chile, 2007, with the support of the IDRC <http://www.efn.uncor.edu/etc/reciclado/web/informacion/Inf3.pdf>

⁶ Adapted from “The implementation of the e-waste Directive in the EU25” Commissioned by: Joint Research Centre - Institute for Prospective Technological Studies. E-Waste Recycling In India – Bridging The Gap Between The Informal And Formal Sector. MAIT-GTZ, GTZ-ASEM, 2010.

⁷ E-Waste Recycling In India – Bridging The Gap Between The Informal And Formal Sector. MAIT-GTZ, GTZ-ASEM, 2010.

⁸ See “China’s Massive High-Tech Waste Woes”, http://ewasteguide.info/newsandevents/china_b2w

⁹ Sustainable Innovation and Technology Transfer Industrial Sector Studies: Recycling – From E-Waste to Resources. StEP Initiative and UNEP, July 2009.

¹⁰ Idem.

¹¹ Diagnóstico de la situación del manejo integrado y sostenible de los desechos de componentes electrónicos en Costa Rica, Victoria Rudin (ACEPESA) – Coordinadora, Susy Lobo (ACEPESA), Maritza Marín A. (ACEPESA), Floria Roa (ITCR), José Emil De La Rocha (CICR), 2003.



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