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# StEP Green Paper on E-waste Indicators

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SOLVING THE E-WASTE PROBLEM

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## Abstract

In this paper we present the results of a project aiming to comparatively evaluate the performance of e-waste policies in four European countries (Belgium, Netherlands, France and Switzerland). Such a comparative analysis could help identify best policy practices used by governments when trying to solve the e-waste problem. The topic of e-waste is getting more and more attention from researchers and politicians given the range of problems at stake. However, it is an under-investigated field of research in social sciences, especially in public policy analysis. EU Member States offer interesting case studies because the Union is an early mover when it comes to addressing the e-waste problem, notably thanks to the Waste Electrical and Electronic Equipment (WEEE) Directive. Since the e-waste problem is a transnational, partly global one, many other countries seek inspiration from European e-waste policies when trying to solve the e-waste problem.

In order to understand how the policies of countries can be improved and the extent to which they can serve as an example for other countries, these policies need to be evaluated. Furthermore, to understand which instruments work best in a given context, a comparative analysis needs to be carried out. To rate the performance of their e-waste policies and report the state of the e-waste problem to the European Commission, Member States have used a wide range of indicators. We introduce in this paper a methodology allowing us to construct the e-waste profile of a country capable of reporting all these indicators in a comparable way. We then comment the results and underline the limits of the approach. Finally, we suggest an alternative to the use of indicators to identify the factors conducive to best policy practices capable of solving the e-waste problem.

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# 1. Introduction

This paper introduces a methodology to comparatively evaluate the performance of e-waste policies. In the EU, e-waste is the fastest growing waste stream, growing at 3-5% per year, which is three times faster than average waste. Outside the EU, an important percentage of this waste is still landfilled, incinerated or recovered without any pre-treatment, which allows dangerous substances such as heavy metals and brominated flame retardants to leak into the environment. Some estimates suggest that 40 million tonnes of e-waste is generated each year, including more than 10 million tonnes in the EU27 only. In addition, used electrical and electronic equipment (EEE) containing hazardous substances are often shipped as reusable EEE to developing countries, where they appear to be nothing else than waste and fail to be treated properly because of the lack of proper infrastructure to do so. This is notably due to the fact that the Basel Convention regulating transboundary shipments of hazardous waste lacks a robust definition of e-waste. To illustrate the variety of definitions of e-waste, the following table provides an overview of the definitions that were circulating in the international arena in 2005:

**Table 1: Overview of selected definitions of WEEE/e-waste**

| Reference | Definition |
|---|---|
| EU WEEE Directive (EU, 2002a) | "Electrical or electronic equipment which is waste… including all components, sub-assemblies and consumables, which are part of the product at the time of discarding." Directive 75/442/EEC, Article 1(a) defines "waste" as "any substance or object which the holder disposes of or is required to dispose of pursuant to the provisions of national law in force." |
| Basel Action Network<br>(Puckett and Smith, 2002) | "E-waste encompasses a broad and growing range of electronic devices ranging from large household devices such as refrigerators, air conditioners, cell phone, personal stereos, and consumer electronics to computers which have been discarded by their users." |
| OECD (2001) | "Any appliance using an electric power supply that has reached its end-of-life." |
| SINHA (2004) | "An electrically powered appliance that no longer satisfies the current owner for its original purpose." |
| StEP (2005) | E-waste refers to "… the reverse supply chain which collects products no longer desired by a given consumer and refurbishes for other consumers, recyclers, or otherwise processes wastes." |

Source: Widmer, Oswald-Krapf et al. (2005).

This heterogeneity has not come to a halt. In October 2010, an analysis carried out by Compliance & Risks C2P knowledge-management tool and database has revealed that worldwide at least 75 different definitions of e-waste existed in the world.

Electronic products vary in hazardous content, high-value content, and ease of recycling. As a result, the scope of products accepted for recycling within current e-waste recycling systems also varies widely. For example, the European Union now requires the recycling of a broad group of electronic products. The European WEEE Directive defines 'EEE' (Electrical and Electronic Equipment) as "equipment which is dependent on electric currents or electromagnetic fields in order to work properly". Thus, each EU Member State must handle all types of e-waste, but may choose to separate certain types of e-waste into different streams. For example, in the Netherlands, ICT-Milieu handles the category 3 (IT and Telecommunications Equipment), while its counterpart NVMP is responsible for all other categories of e-waste. In other countries, the scope of e-waste products handled within mandated systems is much smaller. For example, the US state of Maine only collects display devices (TVs, computer monitors, and laptop computers).

Finally, the economic, environmental, social and geopolitical consequences of the increasing tension around the trade of rare earths make proper e-waste recycling a must for ICT-driven economies. For example, Umicore underlines that in 2006 demand for metals has grown by a two digits rate for those entering the production chain of TV-LCD (+40%), laptops (+30%), digital cameras (+20%), or mobile phones (+15%).[1]

It is therefore paramount to design e-waste policies that are efficient and properly enforced. For this purpose, reliable indicators must be constructed and data collected; then, further improvements can derive from learning from best practices and by comparing different policies. This paper demonstrates how indicators have been used by various countries to do so and underlines the limits of a comparative analysis solely based on indicators. It suggests an alternative methodology to investigate the factors conducive to best e-waste policy practices. It starts with a review of how indicators are used in environmental policy evaluation, followed by an introduction to e-waste policy evaluation. Then, it presents a methodology to comparatively evaluate e-waste policies, before drawing lessons for e-waste policy-making and highlighting the limits of using indicators to bring out best e-waste policies in the conclusion.

# 2. Indicators for environmental policy evaluation

Evaluating environmental policies is key to their improvement and to justify their undertaking in the eye of the citizens who pay taxes to finance them and who may support their objectives. As opposed to policy appraisal,[2] evaluation is an ex post analysis that assesses the success of a policy and what lessons can be learnt for the future. It can be complemented with policy appraisals, in order to question the legitimacy, accountability and normative justification for public action and its embedded and seemingly neutral instruments (Turnpenny, Radaelli et al. (2009).

As Lehtonen (forthcoming) puts it; "Indicators are employed to monitor policy performance and foster accountability". However, indicators are not neutral, as they can for example be used by policy makers to their own advantage. The author argues that they "have been shown or assumed to exert powerful influence on policies and societies at large, not least because they are seen to provide rigorous, quantifiable data".

Therefore, caution must prevail when using indicators to evaluate public policies. This is all the more important since they have a strong indirect influence on frameworks of

[1] Source: Hagelüken and Buchert (2008).

[2] Process of examining ex ante the options for meeting policy objectives and weighing up their costs, benefits, risks and uncertainties.

thought or on how public problems are shaped.

The complex dynamics at stake in the initial phase of a public policy was highlighted by Gusfield (1980) in his analysis of the "Drinking-Driving" public problem. We shall examine this phase in the next section by exploring how the e-waste problem has emerged, and how indicators have been used to construct this public problem.

# 3. Evaluating e-waste policies

## 3.1. The genesis of e-waste policies

When the Basel Action Network (BAN), an NGO serving as a watchdog for the Basel Convention, released its fist documentary "Exporting Harm: The High-Tech Trashing of Asia" in 2003, the European Community Directive 2002/96/EC on waste electrical and electronic equipment (WEEE) was just coming into force. When BAN released its second documentary in 2005 ("The Digital Dump: Exporting Re-Use and Abuse to Africa"), this Directive which sets collection, recycling and recovery targets for almost all EEE was officially being implemented (13 August).

But this piece of legislation came a long way. The first draft of the WEEE Directive was issued in early 1998, but was harshly criticized by industries all over the world (US, EU, Japan, Canada, Australia ...) for failing to back material bans and extension of producer responsibilities with sound scientific evidence. Its scope was said to be too broad and industry had not been consulted. In July 1998 a second draft circulated without further integration of industries' concerns; although the electronics industry did not officially oppose the principle behind the directive, it started organizing a collective counter-attack, especially against the costly matter of material bans. Prepared in a similar fashion, the third draft transpired in July 1999. The subsequent versions and revisions of the directive will keep sparking industry fury, leading Huisman (2006) to call it "An old-fashioned Directive". Indeed, the author stresses that "large parts of the EU WEEE Directive [were] written in a time (around '96) where the thinking was dominated by looking at ways to: 'do good for the environment' with the Extended Producer Responsibility (EPR) principle as a starter", without looking at enforceability. Perhaps a consequence of such an outdated way of crafting European legislation, the WEEE Directive fell short of meeting its key objective to provide incentives to ecodesign EEE for easier dismantling, recycling, and reuse of components (Castell, Clift et al. (2004)).

The Directive required EU Member States to transpose its provisions into national laws by 13 August 2004; only Greece and Cyprus could eventually meet this deadline.3 In other parts of the world, governments have also taken steps to solve the e-waste problem. In the USA, House representatives have introduced a bill seeking to ban e-waste exports.[4] In China, the government has banned the import of e-waste since 2001 and on 5 March 2009, the Chinese e-waste legislation was introduced; it came into effect in January 2011.

When looking at how e-waste policies have been constructed in Europe and other parts of the world, one can identify that the following actors can contribute to solve the e-waste problem:

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[3] See http://www.bis.gov.uk/files/file29925.pdf (29 July 2010).

[4] See http://www.electronicstakeback.com /legislation/federal_legislation.htm (29 July 2010).

- International non-profit & nongovernmental actors :
  - UN agencies
  - European Commission
- National public actors:
  - Parliaments
  - Government bodies
  - Local authorities
- Private actors:
  - Firms:
    - Producers
    - Distributors
    - Recyclers
    - Refurbishers
    - Service Providers

which are subcontracted by a TPO). In this country, TPOs are non-profit organizations formed by companies manufacturing and distributing EEE; municipalities are free to contract with any of them (one being specialized in energy saving light bulbs) so that they can manage their e-waste flows.[6] The system is financed by the producers who charge it to the consumer in the form of a "visible fee" (*éco-contribution*) that is apparent on receipts. Figure 3 shows how this money is collected and how it circulates between all the actors of the take-back system.


**Figure 1: Stages of the life cycle of EEE**

  - Professional organizations
  - Final users of EEEs (households, professional users of household EEEs)
  - Producer associations (lobbies, industry representatives, ...)
  - Consumer associations
  - NGOs
  - Labour unions
  - Media
- Third Party Organizations (TPOs)[5]

These actors can exert their influence at any of the stages demonstrated in Figure 1 of e-waste generation, starting from the design of the equipment to its end-of-life:

Figure 2 depicts the actors involved in the implementation of the French e-waste take-back system (grey boxes concern activities

## 3.2. Using indicators to compare e-waste policies

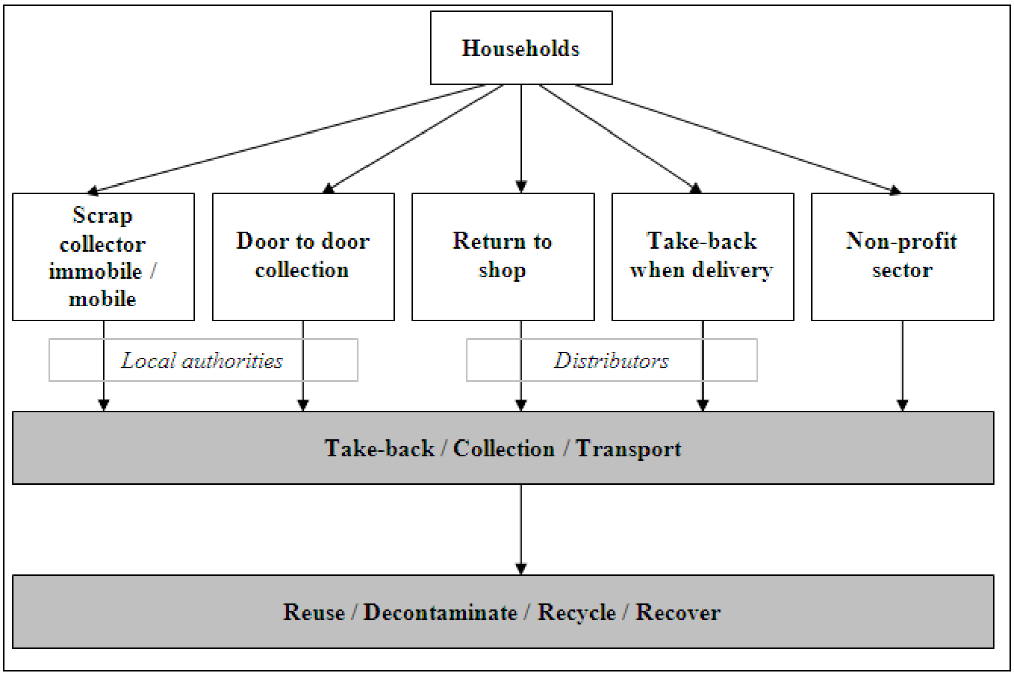
Different methods have been used to evaluate e-waste policies. For example, in order to compare take-back systems in Switzerland and India, Khetriwal, Kraeuchi et al. (2009) first present an overview of the two systems and then compare them on the basis of four criteria:

- E-waste per capita
- Employment Potential
- Occupational Hazards
- Emissions of Toxics

However the selection of these criteria is not robustly justified, since they were chosen "because they feature prominently in discussions related to e-waste". The result of the evaluation in Table 2 gives only an initial qualitative review of the environmental and social aspects.

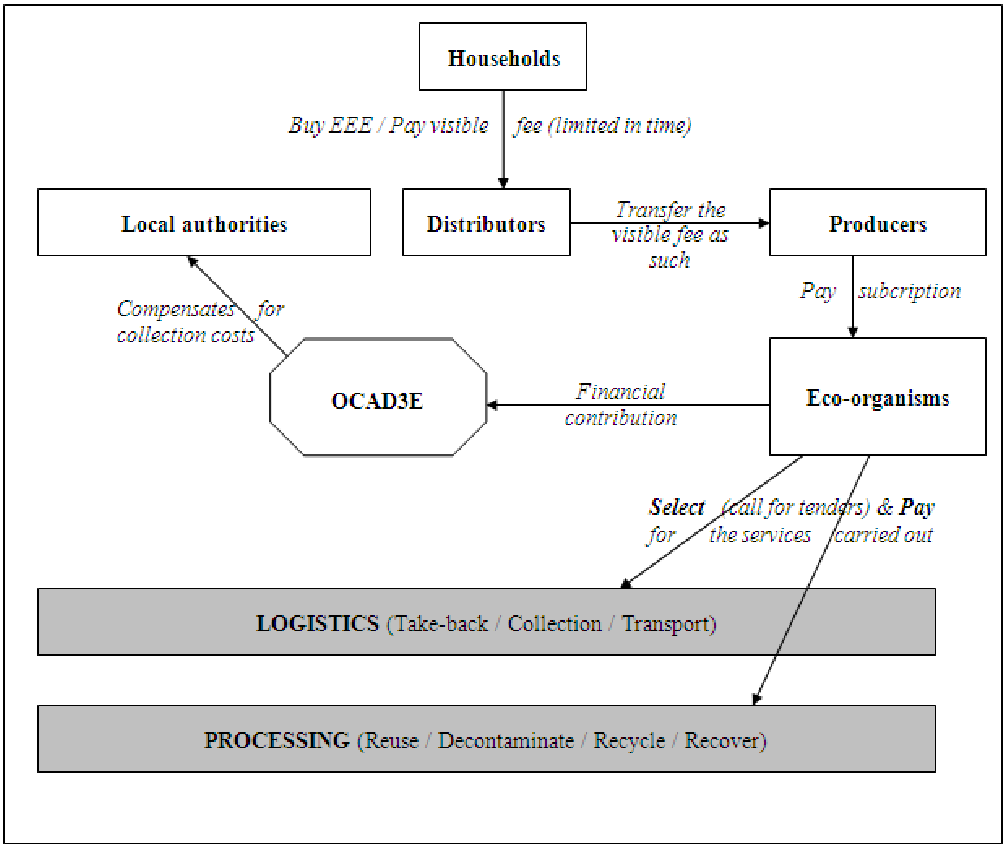
[5] Whatever their legal status might be: NGOs, private firms, governmental bodies...

[6] About the case of an early moving country like Switzerland, see Khetriwal, Kraeuchi et al. (2009).




Source: Adapted from the French Environment Agency (ADEME)

**Figure 2: Physical flows of e-waste in France**




Source: Adapted from the French Environment Agency (ADEME).

**Figure 3: Financial flows in the French e-waste take-back system**

**Table 2: Evaluation results for the comparison criteria**

| Criterion | Switzerland | | India | |
|---|---|---|---|---|
| | Level | Implication | Level | Implication |
| E-waste per capita | High | Negative | Low | Positive |
| Employment Potential | Low | Negative | High | Positive |
| Occupational Hazard | Low | Positive | High | Negative |
| Emissions of Toxics | Low | Positive | High | Negative |

Source: Khetriwal, Kraeuchi et al. (2009).

A more detailed comparative analysis has been provided by Widmer, Oswald-Krapf et al. (2005), who are using the framework in Table 3 to construct the e-waste profile of a country:

**Table 3: Indicator system to measure and compare WEEE management systems**

| Aspect | Criterion | Indicator |
|---|---|---|
| Structural framework | Politics and legislations | Ratification of Basel Convention and Ban Amendment |
| | | Status of a national waste legislation |
| | | Status of a national e-waste legislation |
| | | Corruption perception index |
| | Economy | Capital cost (industrial investments) |
| | | Secondary raw material market |
| | Society and culture | Civil and political liberties |
| | | NGO activities |
| | | Recycling culture |
| | | Environmental awareness in society |
| | Science and technology | Knowledge in WEEE recycling technologies |
| | | Research in WEEE management / recycling technologies |
| Recycling system | Material flow | WEEE generation per capita |
| | | Closed loop recycling management |
| | Technologies | Efficiency of material recovery |
| | | Quality of recovered material |
| | Financial flow | Financial coverage |
| Impacts | Environment | Final disposal of WEEE in unsafe landfills |
| | | Emissions of hazardous substances |
| | Human health | Health and safety implementation at workplaces |
| | | Exposure of neighbouring population to hazardous substances |
| | Labour | Number of jobs generated |
| | | Income distribution |

Source: Widmer, Oswald-Krapf et al. (2005).

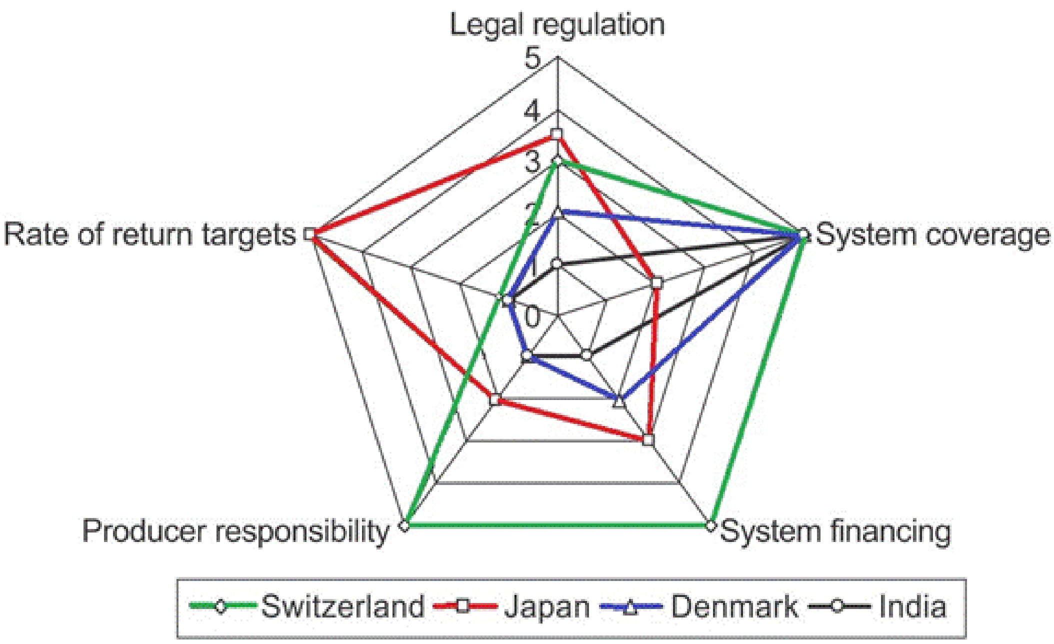
Confronted to the difficulty to collect reliable and comparable data, the authors have used the scale in Table 4 to evaluate the e-waste profile of different countries:

**Table 4: Evaluation of e-waste indicators**

| Comparison indicator | Low (value = 0) | Medium (value = 3) | High (value = 5) |
|---|---|---|---|
| Legal regulation | No existing level regulation | Existing regulation giving operational flexibility | Existing regulation with no operational flexibility |
| System coverage | No WEEE handled by system | Few, specific WEEE handled by system | All WEEE handled by system |
| System financing | No external financing | Partly externally financed system | Fully externally financed system |
| Producer responsibility | Producer responsibility non-existent | Selective producer responsibility | Strong producer responsibility |
| Rate of return targets | No legal collection and/or recycling targets | Few collection and/or recycling targets | Preset, legally binding targets for all processes |

Source: Widmer, Oswald-Krapf et al. (2005).

The outcome is represented on a spider web chart, as exemplified in Figure 4.




Source: Widmer, Oswald-Krapf et al. (2005), colors are ours.

**Figure 4: Comparison of WEEE management systems**

This approach takes a holistic perspective as it takes into account societal objectives such as job creation or income distribution. In many other studies, only the efficiency of the take-back system is taken into account, which reveals that the political priority is not geared towards broader societal issues but merely focuses on the efficiency of e-waste take-back systems. Consequently, academic analyses tend to reflect this focus, not to mention that they are tied to data availability and thus to a restricted scope of comparison of e-waste policies across countries. Table 5 provides a comparative analysis of take-back systems in different countries following a similar approach.

**Table 5: Comparing recycling systems**

| Comparison of Recycling Systems - 2006 Data | | | | Switzerland<br>SWICO | Sweden (EU)<br>El-Kretsen | Netherlands (EU)<br>ICT Milieu | Belgium (EU)<br>Recupel | Norway<br>Elretur | California USA | Maine USA | Maryland USA | Alberta Canada |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| System Architecture | Product Scope | WEEE Category 3. IT and telecommunications equipment | *Monitors* | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | | *Laptops* | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | | *Desktops* | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| | | | *Other* | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| | | WEEE Category 4. Consumer equipment | *TVs* | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | | *Other* | ✓ | ✓ | | ✓ | ✓ | | | | |
| | | All other EU Categories of WEEE (1,2,5-10) | | | ✓ | | ✓ | ✓ | | | | |
| | Collection Methods | Retail Store Take-Back? | | Yes | No | Old for New | Old for New | Yes | No | No | No | No |
| | | Total # of Collection Points | | ~6,000 | 950 | ~7,000 | 2904 | 2500 | 442 | 160 | 18 | 223 |
| | | # of Non-Retail Collection Points | | 431 | 950 | 605 | 537 | unknown | 442 | 160 | 18 | 223 |
| | Financial Structure | Who finances the majority of the system? | | Consumers (ARF) | Producers | Producers | Producers via ARFs | Producers | Consumers (ARF) | Producers | Producers & Government | Consumers (ARF) |
| Context | Population | Population | (million) | 7.5 | 9 | 16.3 | 10.5 | 4.7 | 36.4 | 1.3 | 5.6 | 3.4 |
| | | Poulation Density | (per square km) | 190 | 22 | 489 | 348 | 15 | 90 | 16 | 174 | 5 |
| | Area | Area of Jurisdiction | (sq km) | 39,770 | 410,934 | 33,883 | 30,278 | 307,442 | 423,971 | 91,647 | 32,134 | 640,045 |
| | Wages | Average Recycling Wage (2004 values) | USD/hour | 26.34 | 14.98 | 16.34 | 14.74 | 23.11 | 13.46 | 10.04 | 15.01 | 12.54 |
| | Timing | Date each program began operating | | 1994 | Jul-01 | Dec-99 | Jul-01 | Jul-99 | Jan-05 | Jan-06 | Jan-06 | Oct-04 |
| Performance | Estimated Annual Costs (Financial) | Collection | (USD/kg) | 0.05 | unknown | unknown | 0.06 | unknown | ↑ | unknown | ↑ | 0.04 |
| | | Transportation | (USD/kg) | 0.13 | unknown | unknown | unknown | unknown | 0.37 | unknown | 0.17 | 0.07 |
| | | Processing | (USD/kg) | 0.41 | unknown | unknown | unknown | unknown | 0.55 | 0.26 | ↓ | 0.59 |
| | | System Management | (USD/kg) | 0.09 | unknown | unknown | unknown | unknown | 0.15 | 0.11 | 0.08 | 0.11 |
| | | Total Annual Cost (estimated) | (USD/kg) | 0.68 | N/A | N/A | N/A | N/A | 0.70 | N/A | 0.08 | 0.81 |
| | | | (USD) | 29 million | N/A | N/A | N/A | N/A | 61 million | N/A | unknown | 2.3 million |
| | Annual Quantities (Environmental) | Amount of Category 3 Waste Collected | (million kg) | 28.1 | 27.6 | 18.1 | 12.2 | 10.9 | 16.8 | 0.5 | 0.8 | 1.9 |
| | | | (kg per person) | 3.8 | 3.0 | 1.1 | 1.2 | 2.3 | 0.5 | 0.4 | 0.1 | 0.5 |
| | | Total Amount of WEEE Collected | (million kg) | 42.1 | 149.9 | 18.1 | 76.1 | 68.3 | 58.1 | 1.8 | 2.9 | 2.9 |
| | | | (kg per person) | 5.6 | 16.5 | 1.1 | 7.2 | 14.6 | 1.6 | 1.4 | 0.5 | 0.8 |

Source: Fredholm, Gregory et al. (2008).

This approach suffers from several limits. At first, it is a top-down approach since the criteria upon which the study evaluates the policies are not justified. For example, the study focuses on cost-related indicators, thereby assuming that the priority of take-back system designers is cost minimization, and that for example environmental or societal objectives are not to be integrated in the assessment. Also, the comparison focuses on take-back systems, not on countries, thereby leaving out important factors contributing to solving the e-waste problem such as cultural or political ones, which have a strong influence on the ability of a country to enforce an e-waste regulation. Therefore, if such an approach can provide an informative overview of e-waste policies in different countries, as exemplified in StEP (2009), it falls short of providing justifications for the evaluation criteria chosen to compare different countries and considers a scope of EEE limited to the ICT sector (EU Category 3).

In its review of the WEEE Directive, the United Nations University (2008) was assigned to focus on the environmental impacts of the regulation. It also highlighted the heterogeneity in its enforcement, which was already underlined by the review of its implementation carried out by the Institue for Prospective and Technological Studies IPTS based in Sevilla (2006). In defining the effectiveness of a take-back system, respondents to the interviews conducted for the latter study identified the following indicators:

- Collection rate (kg/inhabitant),
- Percentage of recycling and recovery for each family product,
- Recycling/recovery costs,
- Overall values of reserves within compliance scheme (the lower the better),
- Amount of landfill/incineration volumes.

These studies were carried out in the beginning of the implementation of the WEEE Directive, and many countries had not yet put in place a robust evaluation system. The next section introduces an attempt to overcome these drawbacks and to reflect upon the limits of the use of indicators to evaluate and compare e-waste policies.

# 4. Methodology

The methodology presented here has allowed us to construct an e-waste profile that could be applied to different countries, which could later on be compared. Such a comparative analysis could help identify best practices used by governments to develop effective strategies to address the e-waste issue. A first step has involved the development of a detailed analysis of the indicators used in several European countries (France, Netherlands, Belgium, and France), and a second to construct an e-waste profile that could be applied to a variety of countries.

To shed light on the solutions adopted by different countries when designing their best e-waste policies, the indicators used to construct and evaluate them are analyzed and presented in tabled form. Then, based on this set of indicators, the e-waste profile of a country can be established. Indicators were collected in four countries (Switzerland, Belgium, Netherlands and France), mostly on the basis of reports prepared by take-back systems and other official statistics and confidential data. The following categories have allowed us to organize these indicators in order to ease comparative analyses of e-waste profiles in a later stage; they also show the variety of indicators used by countries which are trying to solve the e-waste problem:

**A. The e-waste problem in the country**

**B. Solutions developed to solve the e-waste problem**

B1. Formulation of the e-waste policy

B2. Instruments used to implement the e-waste policy

B2.1. Legislation

B2.2. Take-back system

- ***Organization***
    - Actors (Private firms, NGOs, Consumer associations, Media, Unions, Third Party Organizations-TPOs)
    - *Economic instruments*
    - *Information-based instruments*

**C. Performance of the solutions put in place**

C1. Collection

C2. Recycling

C3. Costs & Expenses of the take-back system

C4. Revenues & Reserves of TPOs

C5. Treatment & recovery

**D. Context**

D1. General information

- Total population
- Surface
- Population density
- Urban population

D2. Labour market

- Unemployment
- Contribution of the informal sector to the national economy
- Jobs created by recycling schemes (highlight social enterprises)

D3. Health and Safety

- Occupational hazards related to the management of WEEE
- H&S standards of the population living near recycling sites
- H&S standards of workers directly involved in the management of e-waste

D4. Inequalities

- Digital gap
- E-waste leakage

D5. Awareness

- Concern of citizens for environmental and inequality issues

The table in the appendix shows a fictional example of how the availability of these indicators could be mapped in various countries. It draws on the indicators used in the Swiss e-waste profile (available from the author upon request) and includes both quantitative and qualitative indicators. A comprehensive collection of this data has not yet been carried out; this table is provided to show the structure of the indicators selected and what an overview could look like if all data could be collected. However, given the problems related with data heterogeneity and erratic collection in many parts of the world, such a comprehensive approach will not allow us to benchmark countries across the world regarding the performance of the e-waste solutions they have put in place. Therefore, we suggest developing a simpler indicator to evaluate the performance of the solutions developed in different countries to solve the e-waste problem.

## 5. Sustainability through indices

For subjects broader than e-waste, attempts have been made to construct composite indicators, for example to benchmark sustainable development achievements. Van de Kerk and Manuel (2008) have constructed a sustainable society index (SSI), which "integrates the most important aspects of sustainability and quality of life of a national society in a simple and transparent way" (it consists of 22 indicators grouped into 5 categories and has been developed for 150 countries).

In a paper entitled "Measuring the immeasurable -- A survey of sustainability indices", Böhringer and Jochem (2007) review the explanatory power of various sustainability indices applied in policy practice, and conclude that "these indices fail to fulfil fundamental scientific requirements making them rather useless if not misleading with respect to policy advice". They find that normalization and weighting of indicators are often associated with subjective judgments, but that scientific rules exist to guarantee consistency and meaningfulness of composite indices. In a paper entitled "Sustainability of nations by indices", Siche, Agostinho et al. (2008) suggest ways to overcome these difficulties for the Environmental Sustainability Index for example, which "would be more useful if it disaggregated into its individual components, allowing the user to decide on appropriate weights".

Provided that these obstacles are overcome, a composite index measuring the performance of e-waste solutions could be developed. It should also not repeat the limit of the aforementioned evaluations of take-back systems which are mostly top-down analyses. We suggest developing a "post-normal" index evaluating the performance of the solutions adopted by countries to solve the e-waste problem.[7] Indeed, not only does this research seek to conceptualize such an index, it also examines the extent to which it can be applicable in practice. Even in Europe the performance of countries' e-waste solutions is very heterogeneous, and improvements in the performance of these solutions are limited by a lack of good quality data. Having a visible albeit composite indicator evaluating the performance of the solutions adopted in a given country to solve the e-waste problem could help engage citizens and policy-makers in this major challenge. It would create incentives for countries to catch up with others and to collect and diffuse better quality data. It could also increase transparency and foster the development of more reflexive policies that challenge existing policy frameworks, goals and underlying norms, since better informed stakeholders would be empowered to question the very premises of policies.

Besides, in spite of the production of comprehensive studies comparing e-waste policies, in the EU for example there are still huge discrepancies concerning the performances of the solutions developed in Member States to address the issues surrounding e-waste. Such studies might benefit from the existence of a more visible and pedagogical index, even if it is not as comprehensive as them.[8] An index can be defined as a number derived from a series of observations, and used as an indicator or measure to indicate a specific characteristic or property. Examples of such indices include:

- The Human Development Index (HDI),
- IFC and Standard & Poor's carbon efficient index for emerging markets,[9]
- U.S. Standard & Poor's Carbon Efficient Index,[10]

[7] For a presentation of this index, see http://etos.it-sudparis.eu/membres/CedricGossart/Recherche/Gossart_Huissman.ppt (29 July 2010).

[8] The limits of evaluation studies are regularly underlined by evaluation experts, including the ones working on sustainable development issues. See the last Easy-Eco conference that took place in Brussels in November 2010, http://www.sustainability.eu/easy/?k=conferences&s=brussels (29 July 2010).

[9] Aims to encourage carbon-based competition among emerging-market companies. See http://www.ifc.org/ifcext/sustainability.nsf/Content/Publications_SustainableInvesting_Brochures (29 July 2010).

- Dow Jones Sustainability Indexes,[11]
- Ethibel Sustainability Index,[12]
- Sustainable Society Index,[13]
- Ecological Footprint (EF),[14]
- Environmental Sustainability Index (ESI).[15]

As far as e-waste issues are concerned, initiatives seeking to create simple and visible performance measures have also been taken, such as the "Guide to greener electronics"[16] or the "Solar Company Scorecard"[17] (Silicon Valley Toxics Coalition). Based on preliminary studies carried out by Huisman[18] and others a composite e-waste solutions index (ESI) could be constructed, by consulting key stakeholders concerned with and involved in providing e-waste solutions. It would express in a single number for a given country the percentage of objectives achieved by this country to solve the e-waste problem (collection rate of e-waste, recycling rate, treatment specifications, etc.). It would allow us to benchmark the performance of various countries and should support their efforts in solving the e-waste problem.

To do so, a composite index summarizing the performance of e-waste solutions in a given country requires that all stakeholders need to be consulted. Although it will not capture all issues at stake, it should provide a reliable picture of the performance of e-waste solutions in a variety of countries. In addition, the proposed framework should accommodate cases in both developed and developing countries.

Böhringer and Jochem (2007) have underlined the limits of sustainability indices such as the HDI or the EF that provide a one-dimensional metric to valuate country-specific information. We argue with Hezri and Dovers (2006) that by taking a "post-normal turn",[19] namely provided that they are developed with users, indicator systems can overcome part of these problems and co-optimize both scientific and symbolic objectives. Indeed:

"With a post-normal orientation, indicators are mobilized not only toward instrumental and conceptual utilization, but encompass tactical, symbolic and political utilization. In all cases, the marketability of indicators is a critical consideration to ensure they will pass the cognitive screening of potential users, linking the informational content to the chain of action in strategic advocacy."

Particular attention should be paid to the limits of such indicators, since "policy decisions can be ineffective or even counter-productive if they do not consider factors which influence index behaviour", such as the scale of available data and the weighting of indicator data (Mayer (2008).

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[10] http://www.standardandpoors.com/indices/sp-ifci-carbon-efficient/en/us/?indexId=sp-ifci-carbon-efficient (29 July 2010).

[11] http://www.sustainability-index.com (29 July 2010).

[12] http://www.ethibel.org/subs_e/4_index/main.html (29 July 2010).

[13] See Van de Kerk and Manuel (2008).

[14] For a definition and comparison between the EFI and the ESI, see Siche, Agostinho et al. (2008).

[15] Composite index published from 1999 to 2005, http://sedac.ciesin.columbia.edu/es/esi (29 July 2010).

[16] See http://www.greenpeace.org/international/campaigns/toxics/electronics/how-the-companies-line-up (29 July 2010).

[17] See http://www.solarscorecard.com (29 July 2010).

[18] See http://www.step-initiative.org/projects/project.php?id=180 (29 July 2010).

[19] See Funtowicz and Ravetz (1994).

# 6. Conclusion

The United Nations University (2008) study has underlined the discrepancy in the implementation of the European WEEE Directive, notably because the text was not specific enough regarding enforcement procedures, hoping that such flexibility would make implementation easier. This heterogeneity makes it difficult to compare e-waste policies in EU countries, since EU Member States may have chosen different paths to implement the same directive, resulting in the selection of different indicators to evaluate it. Indeed, data collected from official and confidential sources proved not to be consistent and reliable enough to carry out comparative analyses, even in the case of Switzerland and the Netherlands, two “early moving” countries. Moreover, using indicators to evaluate e-waste policies raises difficulties related to the construction of indicators themselves, since they are not neutral and can allow governments to indirectly legitimize a certain policy orientation for which no consensus could be achieved. Provided that good quality data is available, using indicators to compare e-waste policies could help bring out best policy practices; on the other hand, it also raises methodological problems, since indicators may not be comparable if used in different contexts.

This advocates in favor of a model-based approach to complement erratic data quality[20] and of a simplified set of indicators to roughly benchmark countries against one another: the E-waste Solutions Index (ESI), in a similar fashion to the aforementioned spider web developed by Widmer, Oswald-Krapf et al. (2005). As evidenced by the European 7th Framework Programme (FP7) POINT project, spending a lot of time developing sets of indicators does not mean that they will be used in the policymaking process.[21] Therefore, it might be worthwhile developing a simple set of indicators that does have an impact on the policy process, especially when it comes to such an urgent issue as e-waste.

[20] This approach is being pursued by a group of StEP related researchers with the “StEP ADDRESS project”, aiming to build an online database of e-waste flows as well as an aggregated E-waste Solution Index (ESI) for any country in the world that will enable them to monitor progress and to compare themselves with others.

[21] See http://www.point-eufp7.info (29 July 2010).

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# 8. Appendix

| Indicators for e-waste policies: An illustration of a mapping of available e-waste indicators | | | | | | |
|---|---|---|---|---|---|---|
| | | **Legend:** | 1 | Data available | | |
| | | | 0 | Data not found | | |
| | | | **Switzerland** | **Belgium** | **The Netherlands** | **France** |
| **A** | **The e-waste problem in the country** | | | | | |
| | Quantities put on market | | 1 | 1 | 1 | 1 |
| | Quantities of WEEE generated | | 1 | 1 | 1 | 1 |
| | Rates of equipment | | 1 | 1 | 1 | 1 |
| | ICT Expenditures per capita | | 1 | 1 | 1 | 1 |
| **B** | **Solutions to the ewaste problem** | | | | | |
| **B1** | **Formulation of the ewaste policy** | | | | | |
| | National legislation on e-waste management | | 1 | 1 | 1 | 1 |
| | Key definitions | Ewaste | 1 | 1 | 1 | 1 |
| | | Disposal | 1 | 1 | 1 | 1 |
| | | Producer responsibility | 1 | 1 | 1 | 1 |
| | | Product scope | 1 | 1 | 1 | 1 |
| | | Recycling | 1 | 1 | 1 | 1 |
| | | B2B and B2C | 1 | 1 | 1 | 1 |
| | | Reuse | 1 | 1 | 1 | 1 |
| | Key principles | Polluter-pays principle | 1 | 1 | 1 | 1 |
| **B2** | **Instruments used to implement the ewaste policy** | | | | | |
| B21 | Legislation | | | | | |
| | Rules to export EEE | Appliances that no longer function | 1 | 1 | 1 | 1 |
| | | Appliances to be cannibalised | 1 | 1 | 1 | 1 |

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## About the StEP Initiative:

"StEP envisions a future in which societies have reduced to a sustainable level the e-waste-related burden on the ecosystem that results from the design, production, use and disposal of electrical and electronic equipment. These societies make prudent use of lifetime extension strategies in which products and components – and the resources contained in them – become raw materials for new products."

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

**Our prime objectives are:**

- Optimizing the life cycle of electric and electronic equipment by
  - improving supply chains
  - closing material loops
  - reducing contamination
- Increasing utilization of resources and re-use of equipment
- Exercising concern about disparities such as the digital divide between industrializing and industrialized countries
- Increasing public, scientific and business knowledge
- Developing clear policy recommendations

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

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

### StEP's core principles:

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

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