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"The limits of indicators in public policy evaluation: The case of e-waste"

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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)[1]. 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 a yet under-investigated field of research in social sciences, especially in public policy analysis. EU countries offer interesting case studies because the Union is an early mover when it comes to addressing the e-waste problem, notably thanks to the WEEE directive (Waste of Electrical and Electronic Equipment). Since the e-waste problem is global, many other countries seek inspiration from European e-waste policies when trying to solve the e-waste problem.
In order to understand how they can be improved and the extent to which they can serve as an example for other countries, these policies need to be evaluated. And 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.

[1] Funded by funded by the StEP initiative (United Nations University, Bonn).

1) Introduction

This paper introduces a methodology to comparatively evaluate e-waste policies. In the EU, electro-scrap is the fastest growing waste stream, growing at 3-5% per year, which is three times faster than average waste. 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 EU_{27} only. In addition, such hazardous wastes are often shipped illegally to developing countries where there is seldom a proper infrastructure to treat them. This notably due to the fact that the Basle convention, which regulates transboundary shipments of hazardous wastes, lacks a robust definition of e-waste. To illustrate the variety of definitions of e-waste, the following table provides an overview of the ones 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 (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 phones, 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, recycles, 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 for the StEP general assembly by the law firm C2P-Compliance & Risks has revealed that worldwide at least 75 different definitions of e-waste existed.

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 WEEE directive of the European Union, 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 country must handle all types of e-waste, but may choose to separate certain types of e-waste into different systems. 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).

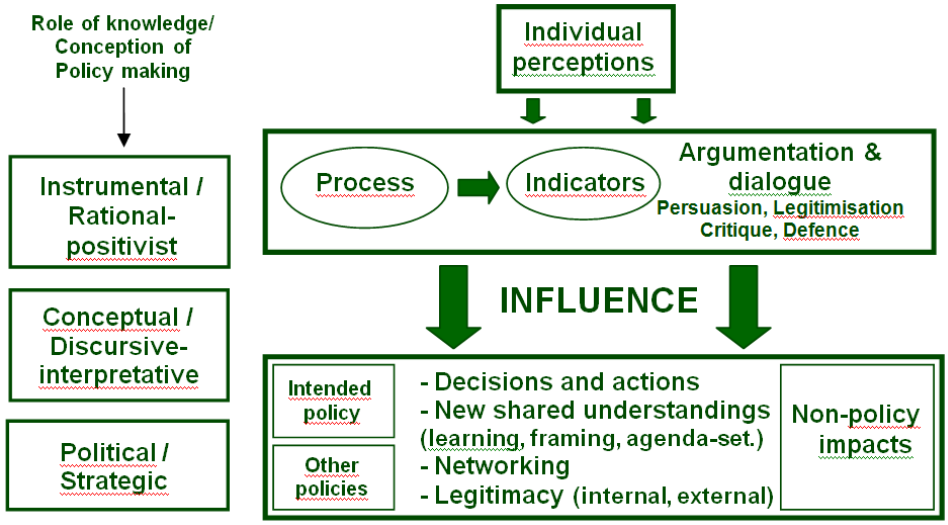
Finally, the economic, environmental, social and geopolitical consequences of the increasing tension around the trade of rare earths make proper e-waste recycling a must for ICT-driven economies. For example, UMICORE underlines that in 2006 demand for metals has grown by a

two digits rate for those entering the production chain of TV-LCD (+40%), laptops (+30%), digital cameras (+20%), or mobile phones (+15%)[2].
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 shows 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 by 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 concluding on the limits of the use of indicators to bring out best e-waste policy practices.

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[3], 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". But 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". He summarises as follows the various types of influence that indicators have on policy making:

Figure 1. Types of indicator influence on policy making

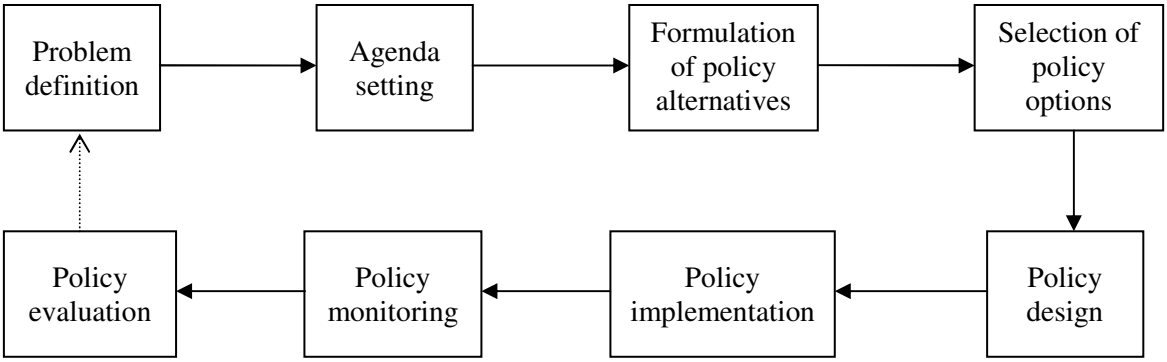


Therefore, caution must prevail when using indicators to evaluate public policies. This is all the more important since they have a strong indirect influence on frameworks of thought or on how public problems are shaped.

[2] Hagelüken, C., M. Buchert (2008), « The mine above ground ». Presentation given to the IERC, Salzbourg (Austria), http://www.preciousmetals.umicore.com/publications/presentations/e_scrap/theMineAboveGround.pdf.
[3] Process of examining ex ante the options for meeting policy objectives and weighing up their costs, benefits, risks and uncertainties.

The following figure shows the importance of this latter phase in the construction and development of a public policy, including in its final evaluation phase:

Figure 2. The phases of public policies



Sources: Howlett and Ramesh (1995), Bardach (1996), Anderson (2005).

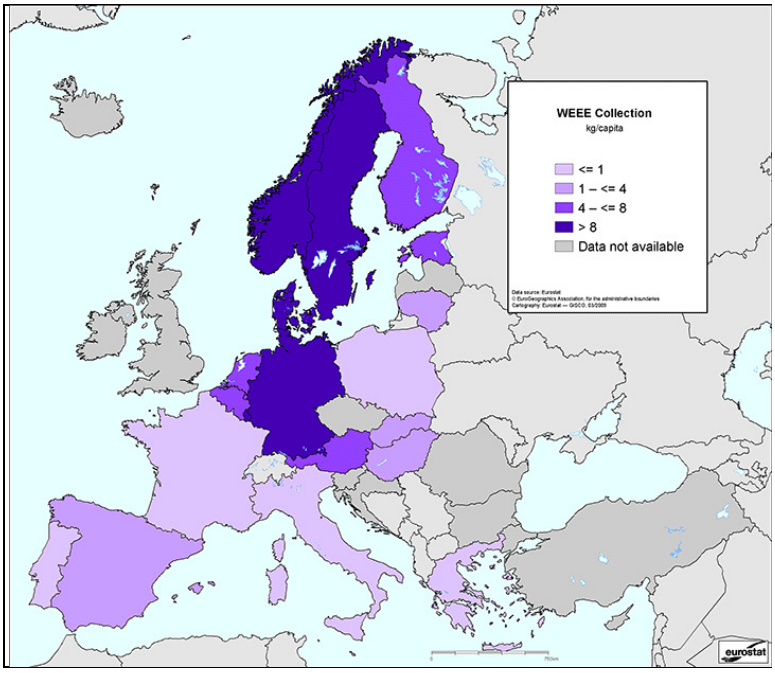
The complex dynamics at stakes in the initial phase of a public policy was highlighted by Gusfield (1980) in his analysis of the "Drinking-Driving" public problem. We shall examine in the next section how the e-waste problem has emerged, and how indicators have been used to construct this public problem.

3) Evaluating e-waste policies

a) The genesis e-waste policies

When the Basel Action Network, an NGO serving as a watchdog for the Basel Convention Secretariat, 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 it released the second one 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 criticised 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 organising a collective counter-attack, especially against the costly matter of material bans. Prepared in a similar fashion, the third draft came out 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, they stress 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 EPR principle as a starter", without looking at enforceability. What might be consequence of such old fashion 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 obliged EU member states to transpose its provisions into national law by 13 August 2004, but only Cyprus met this deadline. One year later, all member states but Malta and the UK had done so. The following map shows the discrepancies in the implementation of the directive in 2006, confirmed by the more recent study of the United Nations University (2008).

Figure 3. Heterogeneous implementation of the WEEE directive



Source: http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/wastestreams/weee.

In other parts of the world, governments have also taken steps to solve the e-waste problem. In the US, the National Centre for Electronics Recycling is supporting these efforts, and on September 30, 2010 U.S. Representatives Gene Green and Mike Thompson introduced a new landmark legislation (the "Responsible Electronics Recycling Act") to stop U.S. recyclers from dumping electronic waste on developing countries. The bill is supported by environmental groups as well as electronic manufacturers Apple, Dell, and Samsung[4]. China has banned the import e-waste since 2001, and on 5 March 2009, the Chinese e-waste legislation was introduced; it will come 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:

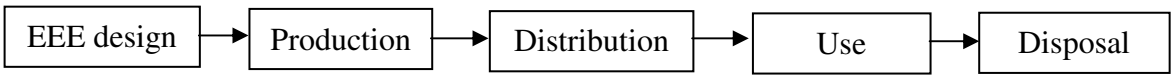
- International non-profit & nongovernmental actors :
  - UN agencies
  - European Commission
- National public actors:
  - Parliament
  - Government bodies
  - Local authorities
- Private actors:
  - Firms:
    - Producers
    - Distributors
    - Recyclers
    - Professional organisations
  - Final users of EEEs (households, professional users of household EEEs)
  - Producer associations (lobbies, industry representatives, ...)
  - Consumer associations
  - NGOs
  - Labour unions
  - Media

[4] See http://www.electronicstakeback.com/legislation/federal_legislation.htm.

- Third Party Organisations (TPOs)[5]

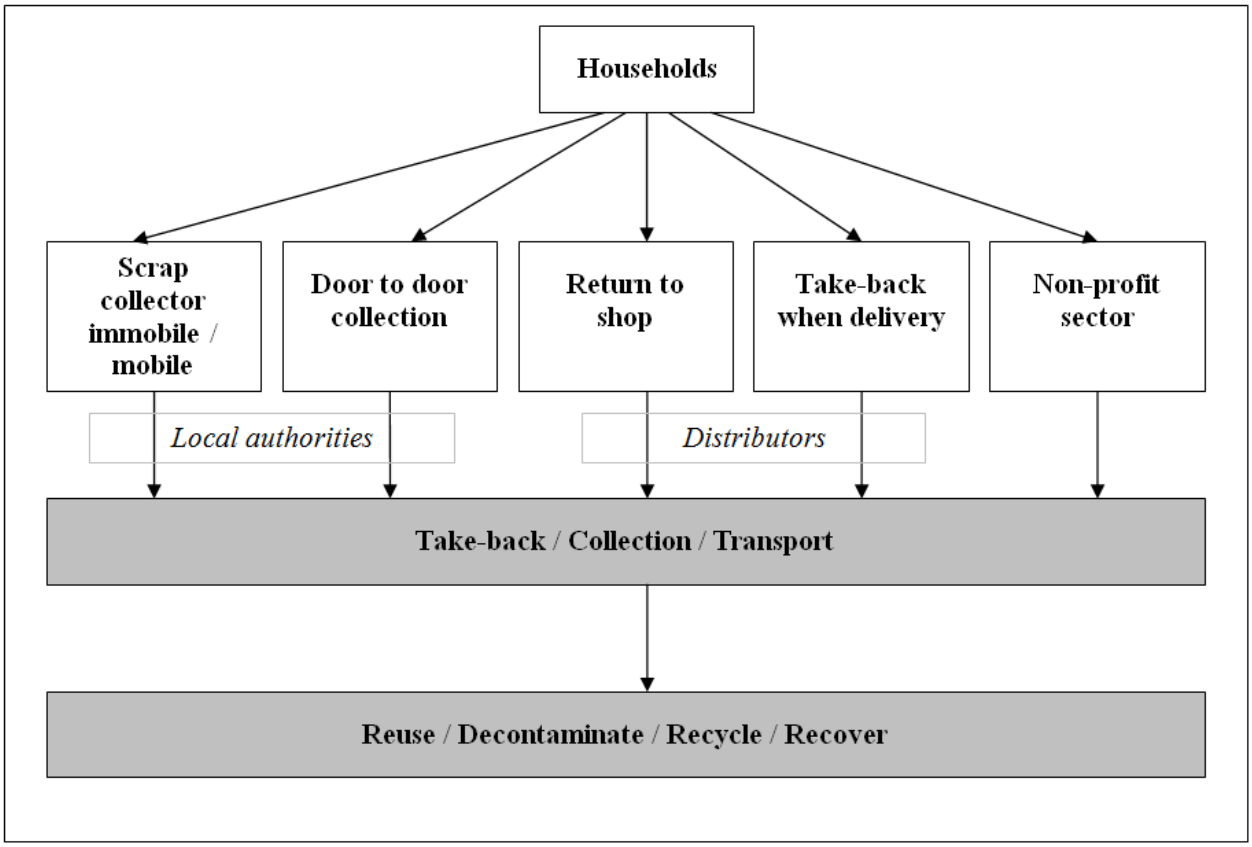
These actors can exert their influence at any of the following stages of e-waste generation, starting from the design of the equipment to its end-of-life:

Figure 4. Stages of the life cycle of an EEE



The next diagram shows the actors involved in the implementation of the French e-waste take-back system (grey boxes concern activities which are subcontracted by a TPO). In this country, TPOs are non-profit organisations formed by companies manufacturing EEEs. Municipalities are free to contract with any of them (one being specialised in energy saving light bulbs) so that they can manage their e-waste flows[6].

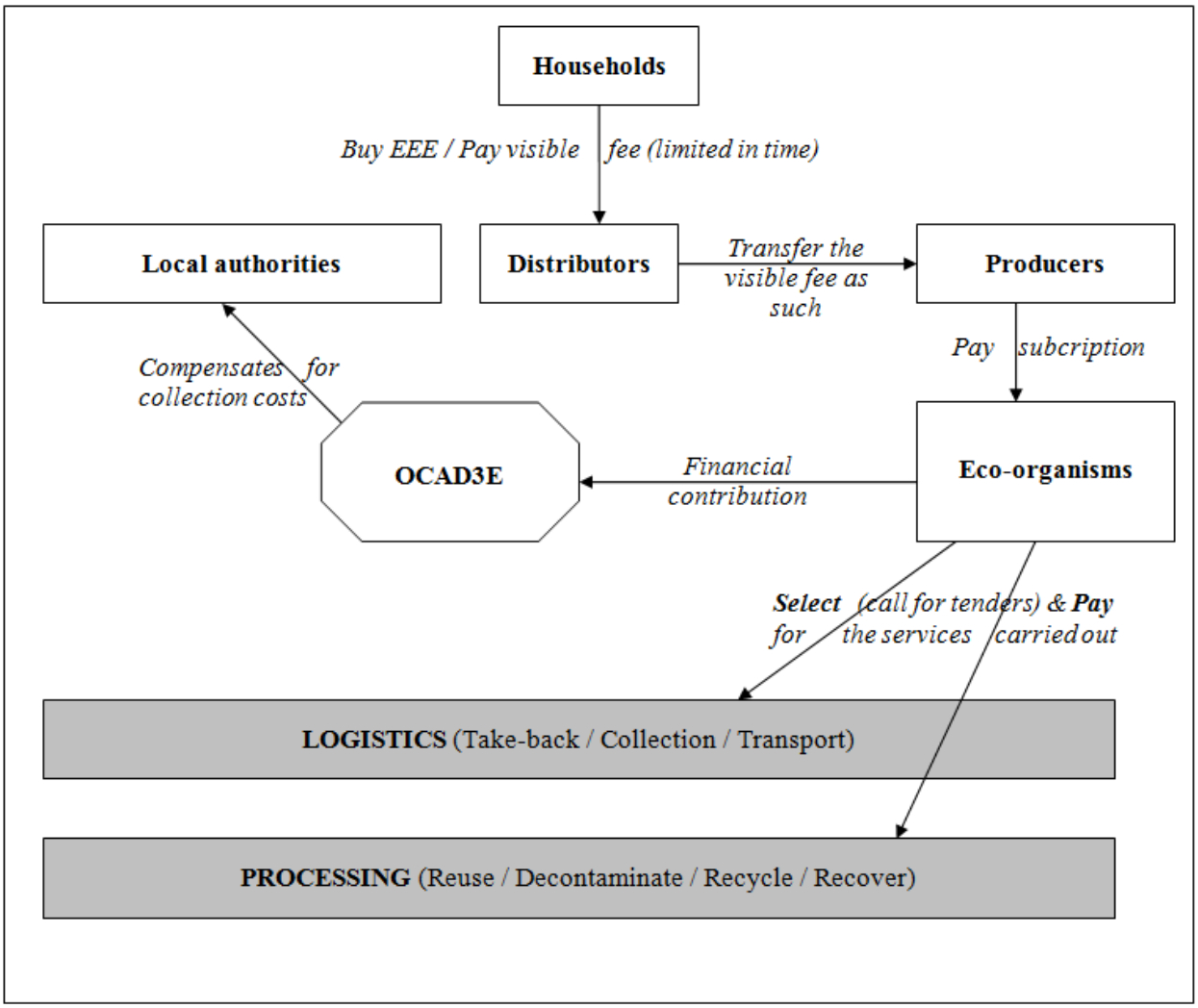
Figure 5. Physical flows of e-waste in France



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. The following figure shows how this money is collected and where it is going.

[5] Whichever legal status they may have: NGOs, private firms, governmental bodies...
[6] About the case of an early moving country like Switzerland, see Khetriwal, Kraeuchi et al. (2009).

Figure 6. Financial flows in the French e-waste take-back system



b) 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 system 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.

But the choice 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 gives only a first qualitative review of the environmental and social aspects.

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

A more detailed comparative analysis has been provided by Widmer, Oswald-Krapf et al. (2005), who are using the following framework 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 legislation	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
		Externalities coverage
		Financial incentives for eco-design
Impacts	Environment	Final disposal of WEEE in unsave 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

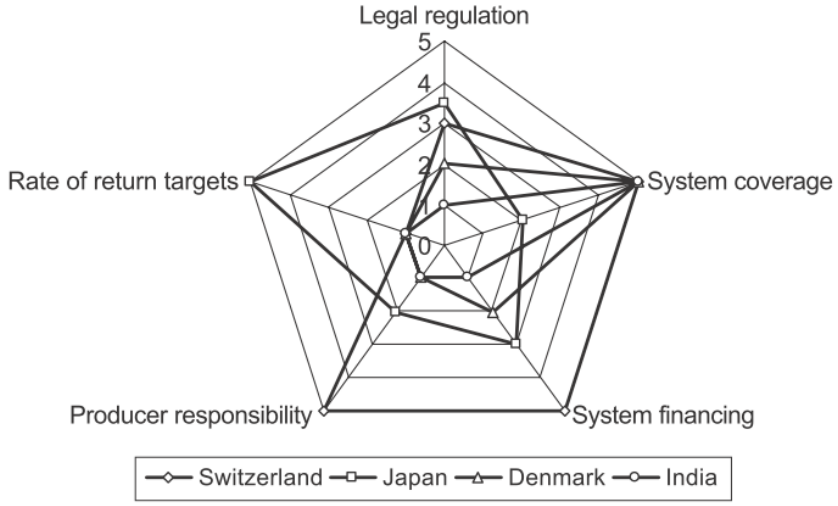
Confronted to the difficulty to collect reliable and comparable data, the authors have used the following scale to evaluate the e-waste profile of different countries:

Table 4. Evaluation of e-waste indicators

Comparison indicator	Low (value=0)	Medium (value=3)	High (value=5)
Legal regulation	No existing legal 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

The outcome is represented on a spider web chart, as exemplified below.

Table 5. 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. The following table provides a comparative analysis of take-back systems in different countries following a similar approach.

Table 6. Comparing recycling systems

Comparison of Recycling Systems - 2006 Data				Switzerland SWICO	Sweden (EU) El-Kretsen	Netherlands (EU) ICT Milieu	Belgium (EU) Recupel	Norway 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	10.6	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)	26.1	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 minimisation, 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 missing out important factors contributing to solve 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) focused 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 IPTS (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.

But these studies were carried out in the beginning of the implementation of the WEEE directive, and many countries had not put in place yet 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 then be compared. Such a comparative analysis could help identify best practices used by governments to solve the e-waste problem. A first step has involved to carry out a detailed analysis of the indicators used in several European countries (France, The 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 analysed 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, 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 organise these indicators in order to ease comparative analyses of e-waste profiles in a later stage:

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
  - B21. Legislation
  - B22. Take-back system
    - Organisation
    - Actors (Private firms, NGOs, Consumer associations, Media, Unions, Third Party Organisations-TPOs)
    - Economic instruments
    - Information-based instruments

C. Performance of the solutions put in place

- C1. Collection
- C2. Recycling rate
- C3. Costs of the take-back system
- C4/5/6. Revenues/Expenses/Reserves of TPOs
- C8. 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 detailed e-waste profile is provided in Appendix 1 in a tabled form.

5) Conclusion: E-waste profiles and beyond

The United Nations University (2008) study had 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 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. Besides, 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 legitimise a certain policy orientation for which they may have had difficulty finding consensus. 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 favour of a model-based approach to complement erratic data quality[7]. Alternatively, a simplified set of indicators could be developed to roughly benchmark countries against one another, in a similar fashion to the aforementioned spider web developed by Widmer, Oswald-Krapf et al. (2005). However, the construction of an e-waste profile has allowed us to underline the limits of quantitative approaches when it comes to comparing e-waste policies. If using quantitative methods does not allow us to identify the key factors leading up to best practices in e-waste policy, a more subjective approach could be used. In order to

[7] 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.

carry out comprehensive policy evaluations, quantitative methods should be supplemented by qualitative methods to avoid "method myopia".
In order to overcome these difficulties, we suggest carrying out a subjective analysis of the factors conducive to best e-waste policies by which actors subjectively (i.e. from their own point of view) evaluate the importance of each factor on a zero to four scale. The questionnaire is currently being submitted to StEP members (see Appendix 2 for an introduction). It will allow us to carry out this subjective evaluation[8] of the perceived impacts of certain factors on the outcome of e-waste policies, and to bring out a set of factors conducive to best practices in e-waste policies.

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[8] For an example of the subjective measurement of impacts, see OECD (2009), Guide to Measuring the Information Society, p. 52. http://www.oecd.org/dataoecd/25/52/43281062.pdf.