

**What exists
elsewhere?**

What do we have?



**What are
the gaps?**

Let's act!

**What do we
want?**

5 Steps

**to establish and implement ESM for
used and waste computing equip-
ment**

Manual on Steps to Establish and Implement Environmentally Sound Management for Used and Waste Computing Equipment

5 Steps to ESM for governments

5 Steps to ESM for the private sector

April 2017



BASEL CONVENTION



PACE

Partnership for Action on
Computing Equipment

Foreword

Computing equipment has improved the life of people everywhere. However, as markets expand and communities gain the benefits of increased access to information technology, countries face new challenges in managing electronic products at their end-of-life. According to recent estimates, about 42 million tons of waste electrical and electronic equipment, or e-waste, are generated globally every year. In 2018, the amount of e-waste will amount to 50 million tons; this is an annual growth rate of 4 to 5 per cent.

E-waste is a problem in developing and developed countries alike. For example, the volume of obsolete personal computers generated in developing regions will exceed that of developed regions by 2018. By 2030, the obsolete computers from developing regions will reach 400-700 million units, more than double than those from developed regions, at 200-300 million units.

Faced with a growing e-waste stream, it is an absolute necessity to devise environmentally sound and responsible processes and recycling systems to deal with it. To support and accelerate these processes, this manual provides practical steps for governments and companies to establish, maintain and strengthen the environmentally sound management (ESM) of used and waste computing equipment.

All stakeholders including governments, original equipment manufacturers, consumers and recyclers have a role in promoting ESM of used and end-of-life computing equipment. The technology and skills are available for repair, refurbishment and extended use or re-use by individuals, businesses or in schools etc. Those products which cannot be re-used can be directed to environmentally sound material recovery and recycling, where base and precious metals can be reclaimed while conserving resources and energy. This, among others, also creates jobs and provides employment. All activities need to go hand in hand in a synergistic manner because the life-cycle management of computing equipment involves a wide range of stakeholders who may have different ways of applying ESM as they face different economic and social realities.

This manual summarizes the steps to set up schemes for the ESM of used and waste computing equipment from the government and from the private sector point of view trying to assist and motivate the stakeholder groups to tackle this task from their different perspectives.

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Co-chairs

Partnership for Action on Computing Equipment (PACE)

E-waste comprises of a highly sophisticated blend of metals, plastics and other materials. From a resource perspective, recyclable materials in e-waste represent a true “urban mine”, which could provide a great amount of secondary resources for remanufacture, refurbishment and recycling. For instance, the gold content from e-waste in 2014 worldwide is estimated to be roughly 300 tons, which is equivalent to about 11 % of the global gold extracted from metal ore in 2013.

Despite obvious incentives for recycling of used and end-of-life computing equipment, the recycling rates are still very low. They vary depending on the country and region between 1 – 40 %, on average worldwide only about 13 % of e-waste is recycled.

In theory, every part of end-of-life computing equipment can find continued beneficial use through the value chain, from direct reuse as a complete computer to a part of a slag-construction aggregate. In practice, economic and social restrictions have to be overcome for collection, segregation and material recovery. For example, collection systems have to be set up depending on the logistical and economic infrastructure available in the country. Also, the material composition of computing equipment is different for each manufacturer, for each piece of equipment, and they are always changing as the technology changes.

The Partnership for Action on Computing Equipment (PACE) was launched to propagate the environmentally sound management of used and end-of-life computing equipment by providing guidance to all the different stakeholders that are directly and indirectly involved. Next to guidelines describing technical details on re-use, repair, refurbishment, recycling and material recovery, PACE developed among others this manual to encourage governments and the private sector to increase their efforts to establish, maintain and strengthen the environmentally sound management of used and waste computing equipment.

The different pieces of the puzzle such as the PACE guidelines and the manual fall into place and contribute on a broader context to the implementation of the Basel Convention. Many stakeholders contribute to this puzzle which is played at different levels.

As illustrated in the manual, there are many pieces to be put together to achieve environmentally sound management at the national level such as legislation, reliable data, collection systems, facilities, etc. In that respect, the manual has done a valuable effort to make the steps to environmentally sound management of use and waste computing equipment comprehensive and practical for government’s representatives and the private sector.

Rolph Payet

Executive Secretary

Secretariat of the Basel, Rotterdam, and Stockholm Conventions

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Under the Partnership for Action on Computing Equipment (PACE), the Project Groups 1.1 and 2.1 prepared guidelines on environmentally sound testing, refurbishment, and repair of used computing equipment, and on environmentally sound material recovery and recycling of end-of-life computing equipment. The PACE Working Group asked the two Project Groups to develop, based on the guidelines, a manual to provide governments and companies with an overview of the essential elements to establish, maintain and strengthen the environmentally sound management (ESM) of used and waste computing equipment. The PACE Working Group would like to express its appreciation for the efforts of the Project Groups 1.1 and 2.1 in the preparation of this manual.

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Introduction

The purpose of this manual is to provide governments and companies with an overview of the essential elements to establish, maintain and strengthen the environmentally sound management (ESM) of used and waste computing equipment being collected, refurbished, repaired, recycled, and recovered.

The manual outlines practical steps necessary at the national level to establish and implement ESM for used and waste computing equipment. The document is for use, particularly, in countries where ESM is not fully established with the intention of supporting governments and industries in the process of implementing ESM. ESM can ultimately only be achieved when any sector, including the informal sector, complies with all applicable legislation, requirements and standards.

Table of contents

Five Steps to ESM for governments	9
Step 1: Assess the current realities at national level	9
Step 2: Collect existing information	14
Step 3: Identify gaps and needs	15
Step 4: Define relevant needs and priorities	16
Step 5: Implement activities	18
Five Steps to ESM for the private sector	20
Step 1: Assess the current situation in your country	20
Step 2: Collect existing information	22
Step 3: Assess the situation for establishing a business	23
Step 4: Define relevant needs and priorities	27
Step 5: Implement activities	28
Glossary	30
Appendix	33

1

Assess the current realities at national level

The objective of step 1 is to assess the current realities related to used and waste computing equipment to get a national overview of the situation in your country, including baseline estimates of e-waste flows and practices, in order to have all the important elements from a government's perspective to build an action plan / strategy.

National and/or state or provincial legislative and regulative review

National legislative context:

- Does national and/or state or provincial legislation exist for solid and hazardous waste management in your country?
- Does it cover used and waste computing equipment?
- Are there any other pre-existing national laws and regulations that may be applicable to the various aspects of the ESM of used and waste computing equipment?
- Are there any related laws at the state or provincial level?
- Are national and sub national laws being enforced?
- Does any international or national technical directive on ESM of used and waste computing equipment exist?
- Does the country use any international standard or indicators to assess their used and waste computing equipment management techniques?
- Does the country implement any international standards to assist with the recovery of rare, strategic and precious metals from used and waste computing equipment?

Domestic laws pertaining to exports, imports, and transits of used and waste computing equipment:

- Are there national laws that cover the import, transit, and export of used and waste computing equipment?
- Do the regulations vary for different types of shipments; e.g., repaired computers vs. unprocessed computers?
- Are these laws being enforced?

Multilateral environmental agreements (MEAs):

- Is the country party to the Basel, Rotterdam and/or Stockholm Conventions? Does the country follow the SAICM?
- If so, has your country transposed your legally-binding obligations under these agreements into your domestic laws (“enabling legislation”)?
- Is (Are) the enabling legislation(s) for these MEAs the same as the one(s) previously identified for dealing with used and waste computing equipment management?

Five Steps to ESM for governments

National and/or state or provincial legislative and regulative review

- If not, do any specific conditions applicable to the ESM of used and waste computing equipment exist within the enabling legislation?

Regional environmental agreements (REAs) regarding transboundary movements (export, import, transit) of used and waste computing equipment:

- Is the country a party to any regional waste and chemicals related MEA (e.g. Bamako Convention, Waigani Convention, Izmir Protocol, Central American Protocol)?
- Is (Are) the enabling legislation(s) for these REAs the same as the one(s) previously identified for dealing with used and waste computing equipment management?
- If not, do any specific conditions applicable to the ESM of used and waste computing equipment exist within the enabling legislation?

Trade agreements:

- Is the country a signatory to any bilateral or other applicable trade agreement(s)?
- If yes, has your country transposed your legally-binding obligations under these agreements into your domestic laws ("enabling legislation")?
- If yes, do any conditions apply to the transboundary movements of wastes, especially used and waste computing equipment?

Stakeholder identification

Identify all relevant stakeholders:

For example all government agencies which play (or should play) a role in managing used and waste computing equipment, persons from government, collection centres, repair and refurbishing facilities, brokers, recycling/recovery facilities, solid waste and hazardous waste landfills (with and without liners and leachate controls), waste-to-energy incinerators, transporters, storage/transfer facilities, the informal sector, producers/manufacturers, distributors, importers, exporters, retailers, business association(s), research centres and universities, formal and informal disposal sites, waste generators (such as households and businesses), relevant international organizations, standards developing organizations, non-governmental organizations and any others who are dealing with used and waste computing equipment.



Stakeholders are people or companies that are from far or near concerned with the project, activity or program

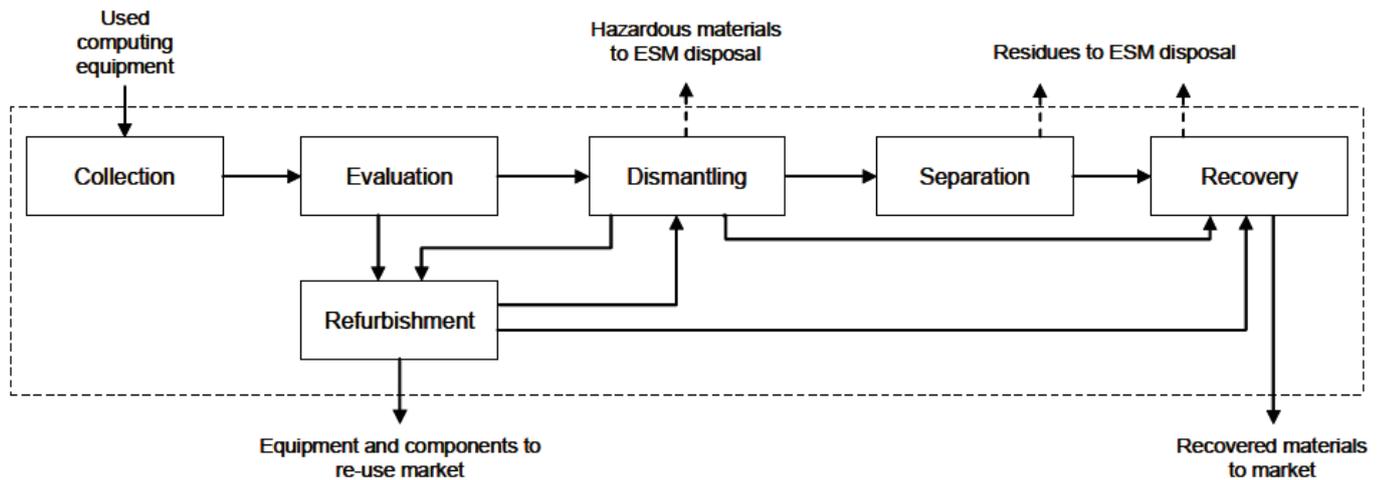
Estimating volumes of used and waste computing equipment

- Try to estimate domestic flows, by quantity and type per year, of used and waste computing equipment¹:
- Estimate the volume of used and waste computing equipment that is available for reuse, recycling and recovery in your country annually.
- Estimate the volume that is currently being collected and reused.
- Estimate the volume that is currently being collected and recycled and recovered.

¹See References UNU-IAS and Step e-waste world map: <http://www.step-initiative.org/step-e-waste-world-map.html>

Five Steps to ESM for governments

- Estimate the volume going to legal final disposal.
- Estimate the volume going to landfills and for incineration, or other types of final disposal.
- Try to estimate the volume being illegally disposed of.
- Try to estimate the volume that is not disposed of in an environmentally sound manner.
- Estimate the volume that is imported and from which country(ies). Clarify if it is legal to import it from those countries.
- Estimate the volume that is exported and the destination.



For each phase of the flow identify the volume of UEOL Equipment

Technical ability

- Identify the existing infrastructures for managing used and waste computing equipment in your country, including existing collection, transportation, storage, refurbishment, recycling, and recovery facilities (such as metals refineries, plastics processors, glass processors, etc.), as well as non-hazardous waste landfills, incinerators (including waste to energy incinerators), and hazardous waste disposal facilities. Include domestic infrastructure, if any, for long term, monitored, and safe storage or treatment of hazardous materials in used and waste computing equipment, such as mercury, phosphors from CRT glass, polychlorinated biphenyls, etc.
- Identify all the fractions that will be created by recycling/recovery operations (including those needing further processing, those needing disposal, and those that may be ready for use as a direct feedstock into manufacturing new products), and determine what infrastructure exists in the country versus what will need to be exported to ESM downstream processors/disposal facilities.
- Identify the existing levels of skilled, trained workers for repairing used and waste computing equipment, safely recovering recyclable materials, and safely disposing of hazardous residuals. This should include an analysis of skilled, trained personnel, availability of personal protective equipment and pollution control equipment to ensure worker's health and safety when repairing or recycling the equipment, as well as environmental protection, such as preventing air emissions, water run-off, and explosions.
- Identify which are the actual categories or scope of used and waste computing

Five Steps to ESM for governments

equipment in your country (such as IT, consumer electronics, medical, etc.) that are sent for reuse, repair, recycling, recovery, etc., and from which type of user or waste generator.

- Identify if there are any domestic companies certified to standards such as ISO 14001, ISO 9001, OHSAS 18001, or RIOS and R2, e-Stewards, or CENELEC, ITU-T L.1000, ITU-T L.1001, ITU-T L.1100 etc.
- Identify how the used and waste computing equipment is recycled and what techniques and technologies are used.
- Identify how ESM is applied in facilities in your country managing used and waste computing equipment.

International & National Technical standards and guidelines:

- Are any international standards and guidelines on the ESM of used and waste computing equipment being utilized in the local context?
- If yes, which ones are used? (e.g. Basel Convention including PACE, ITU, UNEP, OECD)
- If yes, are such standards and guidelines used by the private, the public sector or both? In what context are they used?

Collection

- Is there a collection program for all types of used and waste computing equipment?
- If not, which types of used and waste computing equipment are collected in your country?
- Is there a cost to users to turn in their used and waste computing equipment?
- Are there public and / or private collection points that are convenient to the users and efficient for the collectors across the country? How many collection points are there in total and in terms of tonnages collected? Which areas of the country have adequate collection, and which do not?
- Is there any legal obligation(s) for businesses / importers to become collection points?
- Are any stakeholders responsible for taking back used and waste computing equipment?
- Are equipment manufacturers, importers or other stakeholders required to fund convenient collection systems?
- Is there a collection service for households, door to door? For which types of used and waste computing equipment? How does this service work? Is the service free to the consumer/user?
- Are users/consumers committed to delivering used and waste computing equipment to collection points for free? Or are financial incentives necessary to motivate the consumer to deliver the used and waste computing equipment to collection points?

Public awareness

- Is the general population aware about the environmental and health problems of mismanaging used and waste computing equipment?
- Are there educational programs on used and waste computing equipment in schools in the country?
- Are there any publicity activities regarding used and waste computing equipment?

Five Steps to ESM for governments

Financing aspects

- How is the collection and appropriate repair, refurbishment, recycling, recovery, landfilling, and incineration of used and waste computing equipment financed in your country?
- Are there applicable landfill and incineration fees?
- Do consumers/citizens pay for solid and hazardous waste collection and disposal?
- Are there any additional funding mechanisms available in your country such as prepaid or advanced recycling fees, taxes, recycling funds or government incentives?
- What are the financial flows?
- How is the collection, recycling, recovery, landfilling and incineration of negative valued equipment, parts and fractions from used and waste computing equipment financed?
- Is there a domestic market for recycled material, such as commodity grade steel, copper, circuit boards, aluminium and plastic, in your country?
- Has any national, regional or international financing been provided for activities that support the ESM of used and waste computing equipment?
- Is there an Extended Producer Responsibility (EPR) legislation in place?
- Are there any government incentives for projects (Eco design) or manufacture (green process) of environmentally friendly products?

Project activities

- Has the country participated in any international or regional projects addressing the ESM of used and waste computing equipment and/or wastes?
- Are there any existing plans to be part of such projects?
- Have any key local stakeholders participated in any international or regional projects addressing the ESM of wastes and/or used and waste computing equipment?
- Are there any existing plans for key local stakeholders to be part of such projects?
- (N.B.: projects / project activities include technology transfer, training and public awareness initiatives among other activities)

Others

- Are appropriate government agencies carrying out any kind of long term monitoring of occupational, social and environmental exposures and releases resulting from management / lack of management of used and waste computing equipment (e.g. releases of mercury, CRT phosphors, heavy metals, private data, etc.)?
- Is there a private or governmental data base to identify damage or quality indicators of the system and are data available?
- Has your country a forum in which to discuss the used and waste computing equipment problem with all stakeholders, including industry, commerce, government, universities, research centres and users / consumers?

2

Collect existing information

The objective of step 2 is to provide information and examples about existing laws, regulations and guidelines concerning ESM of used and waste computing equipment to develop/improve national legislation based on the step 1 assessment.

Many legal systems and projects on ESM of used and waste computing equipment have already been developed and put in place in diverse countries. Also, several initiatives have been launched over the past few years so that a number of documentation and guidelines exist on this topic. It appears useful to have a look at the concepts and projects like pilots projects that have already been developed in others countries and other parts of the world. All of the documented experience is a valuable source to get inspire the development of an ESM of used and waste computing equipment.

Information on the following topics should be collected:

- Collection;
- Recovery;
- Recycling/Refurbishment;
- Transboundary movement (TBM), i.e. import, transit, and export; and border controls;
- Final disposal;
- Financing system, e.g. extended producer responsibility (EPR), advanced recovery fees (placed on the sale of new computing equipment), taxes, etc;
- Data security.

(N.B.: Examples of international conventions, regional agreements and national legislations and other regulatory frameworks are provided in the Appendix.

Relevant points to be observed by compiling information about already existing policies and legislation used and waste computing equipment management systems and international agreements are among others:

- Which kinds of used and waste computing equipments are covered by the legislation?
- Which obligation is set by the legislation and to whom it is dedicated?
- How is the collection organized?
- Which stakeholder is responsible to take back used and waste computing equipment?
- Who has the obligation for disposal?
- What are the demands regarding disposal?
- Which components of used and waste computing equipment have special requirements / obligations?
- What is the financing model for the recycling of components of no value? Does the legislation prescribe for example a prepaid recycling fee or contribution?



3

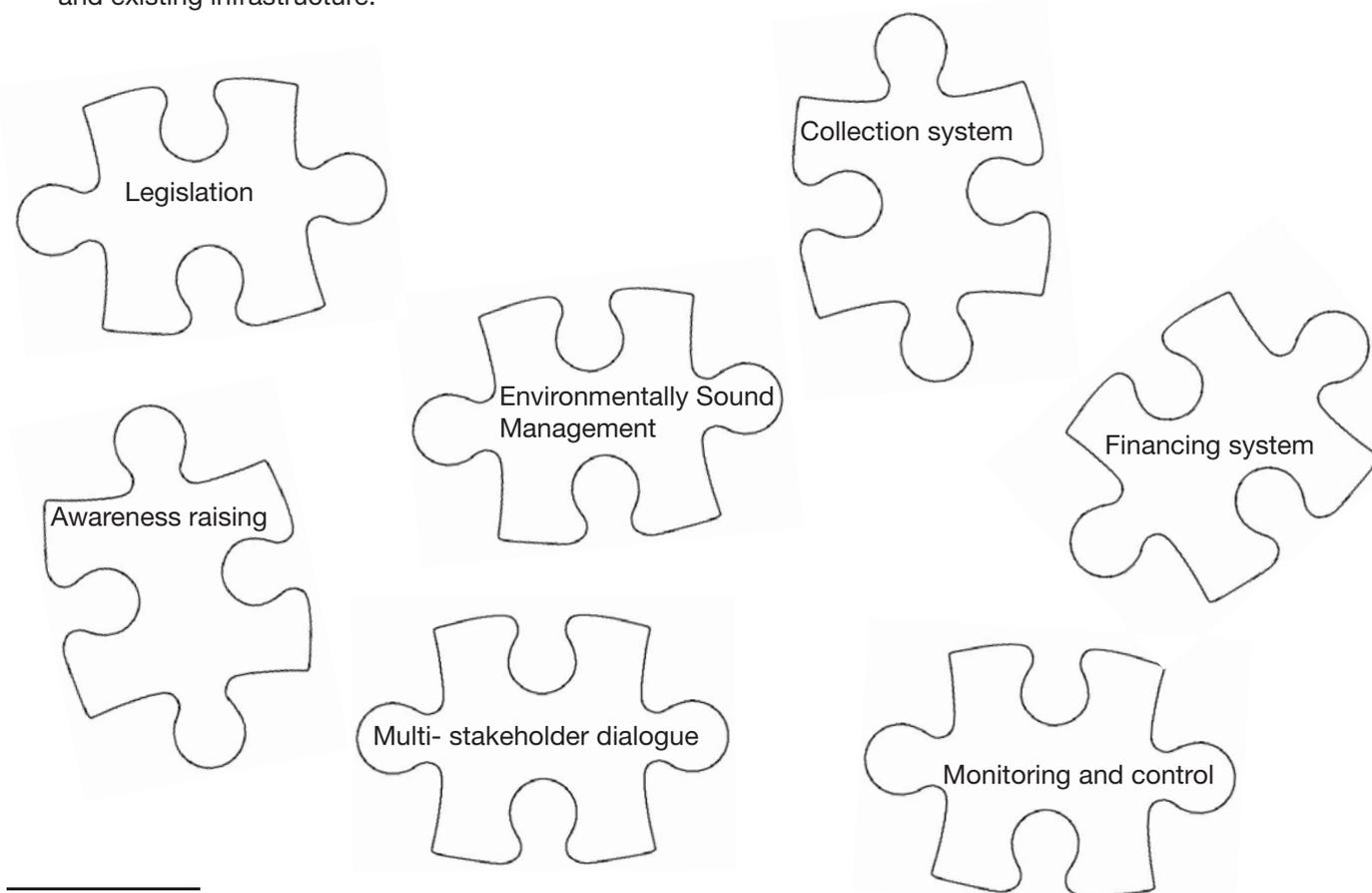
Identify gaps and needs

The objective of step 3 is to identify gaps between existing realities and national needs for an effective approach to managing used and waste computing equipment in an environmentally sound manner.

The identification of gaps and needs should result in a list of activities that could be implemented in a near or far future to reach ESM of used and waste computing equipment. Based on the assessment in step 1 and by having an overview of the experiences of other countries and regional international entities provided by step 2, the gaps in the actual national system can be identified.

Example of gaps and needs that could be addressed:

- Gaps in downstream markets and disposal facilities for both hazardous and non-hazardous materials generated by repairing, refurbishing and recycling used and waste computing equipment;
- Gaps in transposing and implementing international treaty obligations into domestic law and enforcement for export, transit, and import of used and waste computing equipment, e.g. gaps in Competent Authority¹ functionality and response time;
- Gaps identified by analysis of existing relevant national legislation, existing relevant national strategic documents and existing infrastructure.



¹ Pursuant to article 5 of the Basel Convention, Parties are required to designate or establish one or more competent authorities to facilitate the implementation of the Convention.

4

Define relevant needs and priorities

The objective of step 4 is to define the priorities based on the gaps and needs identified in step 3. The result of this step is a list of relevant needs and activities that should be addressed when establishing or improving the ESM of used and waste computing equipment.

Each component under point 3 is part of the puzzle for an ESM strategy for used and waste computing equipment. Other components can be added. For each components, activities can be listed and prioritized according to their degree of importance and necessity.



Below examples that should be addressed for each component

Draft or amend legislation(s):

Legislation should at least contain:

- Regulations for solid and hazardous waste management;
- Specific regulations for used and waste computing equipment to ensure ESM;
- Defined responsibilities for key stakeholders covered by the specific used and waste computing equipment law; such as local governments, consumers, small businesses, large businesses, etc.;
- Legal obligations for collection, reuse, recycling, recovery or final disposal of used and waste computing equipment;
- Registrations, permits or other means of authorisation, as needed, for facilities that repair, refurbish, recycle material, recover energy, or finally dispose of used and waste computing equipment;
- Restrictions on the disposal of waste computing equipment;
- Reporting / recording / data management requirements;
- Financing systems, as needed, for the collection and ESM of the used and waste computing equipment;
- Penalties for non-compliance with the law;
- Enforcement mechanisms and responsible agencies/bodies

Five Steps to ESM for governments

Establish or enhance a collection system	<p>Establish collection points and mechanisms in order to ensure environmentally sound collection of used and waste computing equipment from households, communities, commercial entities and government entities.</p> <p>Involve the informal sector:</p> <ul style="list-style-type: none">– How will the informal sector participate in the formal system?– Will there be government incentives?
Define a financing system supporting the ESM of used and waste computing equipment	<ul style="list-style-type: none">– Develop a financing model, such as establishing a recycling fund, advanced final disposal fees or levying of prepaid recycling fees, for negative valued used and waste computing equipment and components.– Identify policies that attract industry and investments (incentives, awards, green procurement, etc).– Provide incentives for the development of an end-use market for reusable and recycled materials derived from used and waste computing equipment.
Implement requirements regarding the treatment of used and waste computing equipment	<ul style="list-style-type: none">– Identify and implement the requirements for the collection, reuse and repair, recycling, recovery, landfilling and incineration of used and waste computing equipment. <p>(See example of PACE guidelines on ESM)</p>
Monitoring and control	<ul style="list-style-type: none">– Define monitoring and control mechanisms to manage permits, manifests and any accompanying forms.– Monitor facilities, either public or private, that manage used and waste computing equipment as appropriate.
Awareness raising	<ul style="list-style-type: none">– Design and execute national public awareness campaigns on the used and waste computing equipment issue and national initiatives for the environmentally sound management of used and waste computing equipment, such as environmental education programs and collection campaigns.
Create a multi-stakeholder dialogue	<ul style="list-style-type: none">– Evaluate the role of a multi-stakeholder dialogue and establish a multi-stakeholder forum that will serve as part of the implementation, monitoring and assessment mechanisms for the used and waste computing equipment activities and development of the management system.

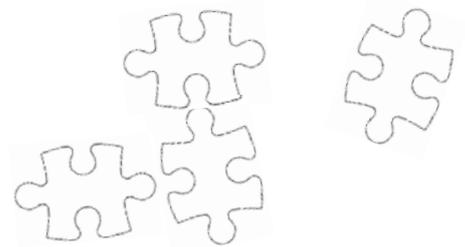
5

Implement activities

The objective of step 5 is to define a roadmap and/or a national action plan on ESM of used and waste computing equipment in order to implement the activities listed in step 4.

Depending on the situation in the country, the following outcomes should be achieved:

- Establish and conduct a coordinating mechanism and organization process;
- Set goals, national objectives and targets;
- Formulate an implementation plan;
- Implement the roadmap and/or the national action plan on ESM of used and waste computing equipment;
- Develop a monitoring and evaluation mechanism for the plan.



For each component, list the activities, their related costs, deadlines, responsible organisation and indicators

Name of the Activity	Activity costs	Timeline	Funding source	Lead agency	Indicator
...					
...					



1

Assess the current situation in your country

The objective of step 1 is to get an overview of the situation in your country regarding the ESM of computing equipment, including baseline estimates of e-waste flow and practices, financial aspects, technical ability and relevant stakeholders in order to have all the important elements to build a business strategy.

Used and waste computing equipment flow

- How much used and waste computing equipment would be available to your business? (quantity of domestically-generated used and waste computing equipment, used and waste computing equipment imported and/or exported?)

Financing aspects

- How is the collection, transport and recycling of used and waste computing equipment financed in your country?
- What are the financing flows?
- How is the recycling of the negative valued used and waste computing equipment and components financed?
- Is there a prepaid recycling contribution, taxes or other financing available?

Technical ability

- What infrastructure exists for the ESM of used and waste computing equipment in your country, including existing repair, refurbishment, recycling, recovery, non-hazardous landfills, incineration and waste to energy, and hazardous waste disposal facilities?
- Which are the categories or scope of used and waste computing equipment (such as IT, consumer electronics, medical, etc.) that are sent for reuse, repair, refurbishment, recycling, recovery, etc in your country?
- What types of technologies are required for your “target” categories of used and waste computing equipment?
- Are there any companies in the country that are certified to standards such as ISO 14001, ISO 9001, or RIOS and R2, e-stewards, GENELEC, etc.?

Five Steps to ESM for the private sector

Stakeholders

- Identify key stakeholders:



- Stakeholders are, for example, persons from government, brokers, recyclers, the informal sector, producers, importers, retailers, consumers association(s), etc., who are dealing with used and waste computing equipment.

Public awareness

- Are there educational programs concerning used and waste computing equipment in schools?
- Are there any publicity activities regarding used and waste computing equipment?
- Are users/consumers in your country committed to delivering the used and waste computing equipment to collection points for free or are there financial incentives in place to motivate consumers to deliver the used and waste computing equipment to collection points?

2

Collect existing information

The objective of step 2 is to identify and assess existing laws, regulations and guidelines that must be complied with concerning the ESM of used and waste computing equipment. Additionally, international agreements should be identified that address used and waste computing equipment management.

Domestic legislation

- Identify whether legislation exists in your country for solid and hazardous waste management.
- Discern whether there are any specific laws that deal with used and waste computing equipment.
- Discern what types of used and waste computing equipment are addressed by the legislation.
- Discern what the legislation requires and the target regulatory audience in terms of compliance.

Organization of domestic collection systems

- How is the collection organized in your country?
- Which stakeholder is responsible for take back?
- Who has the obligation for disposal?
- What are the constraints on disposal? Which components have a special obligation?

Transboundary movement

- Are used and waste computing equipment exports and imports regulated in your country?
- Does the regulation vary for different types of shipments (e.g., repaired computers vs. unprocessed computers)?
- Are these laws enforced?
- Are the countries importing and exporting used and waste computing equipment Parties to the Basel Convention or Basel Convention Article 11 bilateral or multilateral agreements?

Management systems

- Identify management systems that can be applied to used and waste computing equipment in the context of promoting ESM (as ISO 14001, ISO 9001, or RIOS and R2, e-stewards, CENELEC)

3

Assess the situation for establishing a business

The objective of step 3 is to provide guidance to assess the situation for establishing a business based on information gathered in step 1 and step 2.

Establishing a business

- What are the legal requirements for setting up a solid or hazardous waste facility?
- What are the legal requirements for reuse, repair and refurbishment of used and waste computing equipment?
- What are the legal requirements to recycle, recover, or incinerate used and waste computing equipment?
- Which techniques are available for moving and separating components?
- Is there a business opportunity?
- Where do you get material from?
- What legislation is available?
- Is there someone else active in the sector (assess competition)?
- Where are the valuables?
- What has no value?
- Where and how would you access used and waste computing equipment in the market?
- How do you manage downstream waste?
- Which techniques / technologies can be used?
- How can you set up your business model/operations based on incoming waste material as well as available downstream markets and solutions (cement plant, smelter, etc. available)?
- What is the scope of setting up a business, e.g. does government regulate the number of recyclers; are there measures in place to prevent or at least minimise illegal movements/dumping?
- How do businesses work together?
- How closely is the government monitoring and controlling?
- How can you, in a transformatal situation, involve the informal sector?

Five Steps to ESM for the private sector

Commercial considerations

- Develop a business plan that supports your facility “niche” operations capabilities, e.g. collection compared to reuse, refurbishment and repair compared to recovery, in order to be economically viable.
- Establish a plan to ensure that all hazardous substances derived from used and waste computing equipment are managed in accordance with all applicable laws and in an environmentally sound manner.
- Develop business relationships prior to entering the market place for key upstream and downstream markets in order to obtain the necessary volume for recycling and for end use market sales of reusable equipment and commodity grade materials, such as steel, aluminium, copper and plastics.
- Strategically choose your facility location based on proximity to transportation outlets, such as highways, railroads, and ports.
- Acquire any relevant permits, registrations or manifests needed to operate your facility.
- Join a trade association to network with industry leaders to learn about new, innovative technologies and best business practices.
- Analyse values at different steps, e.g. if a collection system is available.

Technical considerations

- What are the requirements regarding the treatment of waste computing equipment?
- What techniques and technologies are required for sorting, processing, recycling, material and energy recovery and final disposal?
- Can the company meet minimum requirements (emission limits, water usage, etc)?
- What is the logistics situation in the country?

Financial considerations

- Are there incentives available for solid and hazardous waste management?
- Are there incentives specifically for used and waste computing equipment?
- Does the legislation prescribe, for example, a prepaid recycling fee or contribution?
- What is the financing model for the recycling of non valued components?

ESM considerations

A used and waste computing equipment management facility should be managed in an environmentally sound manner, i.e. it must meet all basic requirements to ensure ESM of used and waste computing equipment and commit to continual improvement of operations.

The whole life cycle of the facility should be covered, from planning and construction, to its operation and subsequent dismantling or site remediation (in the event of accidents or spills during operation) or site clearance after closure, as appropriate. As such, a facility should meet the approval of the competent authorities concerned.

The facility should have:

- Appropriate design and location of the plant, taking into account potential risks to the environment, including environmentally sensitive areas;
- Where appropriate, an environmental and social impact assessment, which should be conducted and approved by the appropriate authorities before a facility is constructed;

Five Steps to ESM for the private sector

ESM considerations

- Are sufficient measures in place to safeguard occupational safety and health (OSH), including:
 - Measures which meet the requirements of national OSH legislation;
 - Appropriate actions to address significant actual and/or potential risks to the health and safety of the public and of workers, based on a risk assessment, and to correct deficiencies that have been identified, including contingency arrangements in the event of plant breakdown or accidental spillages;
 - An appropriate and adequate training programme for personnel to ensure employees have an appropriate level of awareness, competency and training with respect to the effective management of occupational risks, including the effective management of wastes;
- Are sufficient measures in place to protect the environment, including:
 - Measures to control pollution taking into account emission limit values to air, water and soil;
 - Appropriate actions to address significant actual and/or potential risks to the environment, based on risk assessment, and to correct deficiencies that have been identified, including contingency arrangements in the event of plant breakdown or accidental spillages;
 - Waste acceptance and handling criteria, including measures to ensure due diligence and proper collection, sorting, pre-treatment, treatment, storage and downstream management of wastes and residuals;
- Is there an applicable environmental management system in place, if feasible and appropriate, which:
 - Describes, assesses and reviews the design, construction, operation, monitoring, management and maintenance of the facility and which will be periodically reviewed;
 - Demonstrates compliance with applicable legislation and regulations;
 - Demonstrates the commitment of management to integrating a systematic and consistent approach to achieve ESM in all aspects of facility operations;
 - Includes provisions to support transparency and confirm implementation of ESM by the facility, subject to appropriate protection of confidential business information, which can help assure the public that operations and activities are compatible with ESM. Such provisions may include third-party audits and inspections;
- Is there an adequate and transparent monitoring, recording, reporting and evaluation programme which covers:
 - Relevant legal requirements, including key process parameters;
 - Compliance with applicable safety requirements;
 - Effluents and emissions;
 - Records of incoming, stored and outgoing wastes.
- Is there an adequate emergency plan and response mechanism;
- Is there an adequate plan for closure and aftercare, which includes the identification and remediation of contaminated sites.

Five Steps to ESM for the private sector

- Monitoring and control**
- In the absence of an environmental management system put in place, a system should be established to monitor the performance of the used and waste computing equipment management operations, for both record keeping purposes and to detect discharges, releases, or accidents and to take appropriate actions if performance does not comply with targets.

-
- Capacity building for compliance**
- Set up a workers' protection and an environmental and health system.
 - Ensure compliance with all applicable legal requirements, including transboundary movements, licenses, data security, etc.

4

Define relevant needs and priorities

The objective of step 4 is to establish priorities based on the assessment done in step 3.

Identify the various gaps that exist in step 3 regarding:

- Establishing a business;
- Commercial considerations;
- Technical considerations;
- Financial considerations;
- ESM considerations;
- Monitoring and control;
- Capacity building for compliance.

Based on the assessment, establish priorities to move forward to launch the business based on:

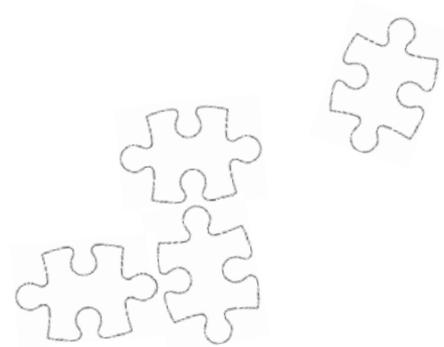
- Material and financing flow analysis;
- Used and waste computing equipment inventory and assessment;
- Actual types of management of used and waste computing equipment at recycling and refurbishment facilities compared to ESM at each facility.

5

Implement activities

The objective of step 5 is to define a roadmap to establish a business on ESM of used and waste computing equipment.

The roadmap for activities should be developed and implemented on the basis of the assessment in step 3 and in order to take action to bridge the prioritized gaps as identified in step 4. The identified gaps will differ case by case depending on the situation in the country and the interest of the company(ies).





Glossary of terms

Note: These terms were developed for the purpose of the report on ESM criteria recommendations, individual project guidelines, and the overall guidance document developed under PACE, to assist readers to better understand these PACE documents.

Assemblies: Multiple electronic components assembled in a device that is in itself used as a component.

Basel Convention: Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, adopted on 22 March 1989 and entered into force in 1992.

Cleaning: Removal of dirt, dust and stains and making of cosmetic repairs.

Component: Element with electrical or electronic functionality connected, together with other components and usually by soldering, to a printed circuit board to create an electric or electronic circuit with a particular function (for example an amplifier, radio receiver, or oscillator).

Computing equipment: Computing equipment includes personal computers (PCs) and associated displays; printers and peripherals; personal desktop computers, including the central processing unit and all other parts contained in such computers; personal notebooks and laptop computers, including any docking station, the central processing unit and all other parts contained in such computers; computer monitors, including cathode ray tube monitors, liquid crystal display monitors and plasma monitors; computer keyboards, mice and cables; computer printers, including dot matrix printers, inkjet printers, laser printers, thermal printers and any computer printers with scanning or facsimile capability.

Defective/Defect: Defective computing equipment is equipment that is delivered from the last manufacturer in the supply chain in a condition that is not as it was designed to be sold, or equipment that breaks or malfunctions due to a condition that was not intended as part of the equipment's design. Defective equipment does not include equipment that loses functional or cosmetic value as a result of normal wear and usage or consumer negligence.

Direct reuse: The using again, by a person other than its previous owner, of computing equipment and components that are not waste for the same purpose for which they were conceived without the necessity of repair, refurbishment or hardware upgrading.

Dismantling: Taking apart computing equipment, components or assemblies to separate materials and/or increase options for reuse, refurbishment or recycling and to maximize recovery value.

Disposal: Any operations specified in Annex IV to the Basel Convention (paragraph 4 of Article 2 of the Convention, and appendix II to this document).

End-of-life computing equipment: Computing equipment that is waste and no longer suitable for use and is intended for dismantling and recovery of spare parts or is destined for material recovery and recycling or final disposal. It includes off-specification or new computing equipment that has been sent for material recovery and recycling or final disposal.

Environmentally sound management (ESM): The taking of all practicable steps to ensure that wastes are managed in a manner that will protect human health and the environment against adverse effects which may result from such wastes.

Essential key function: The originally intended function(s) of a unit of equipment or component that will satisfactorily enable the equipment or component to be reused.

Evaluation: The initial assessment of used computing equipment to determine whether it is likely to be suitable for refurbishment, repair, material recovery or recycling.

Final disposal: Disposal operations specified in Annex IV A to the Basel Convention (appendix II, section A, to this document).

Fully functional/Full functionality: Computing equipment or components are fully functional when they have been tested and demonstrated to be capable of performing the essential key functions that they were designed to perform.

Hydrometallurgical processing: The uses of aqueous chemistry for the recovery of metals from ores, concentrates or recyclable wastes or products. Typically, hydrometallurgy consists of three steps:

- i) Leaching of an intermediate product with acid, caustic, or a complex forming solvent, often combined with oxidation to dissolve the desired element(s) at ambient or elevated pressures and temperatures;
- ii) Purification of the solution by:
 - (a) precipitation of insoluble compounds,
 - (b) cementation of unwanted metals (using another metal to precipitate the metal in solution); or
 - (c) solvent extraction;
- iii) Precipitation of desired product, either as an insoluble compound or as a metal either by chemical or electrochemical methods.

Recycling reagents and treatment and disposal of effluents and residues are further important steps that occur throughout the process. Hydrometallurgical operations in authorized industrial-scale facilities are distinct from unauthorized and illegal environmentally harmful practices in the informal sector.

Incineration: A thermal treatment technology by which wastes, sludge or residues are burned or destroyed at temperatures ranging from 850° C to more than 1,100° C.

Labelling: The marking of computing equipment, individually or in batches, to designate its status according to the PACE guidelines.

Landfilling: The deposit of waste into land (i.e., underground), or onto land.

Material recovery: Relevant operations specified in Annex IV B to the Basel Convention (appendix II, section B, to this document).

Mechanical separation: Using machinery to separate computing equipment into various materials or components.

Potential for reuse (reusable): Computing equipment and its components that possess or are likely to possess the quality necessary to be directly reused or reused after they have been refurbished or repaired.

Pyrometallurgical processing: Thermal processing of metals and ores, sludges and residues including roasting, smelting and remelting with the aim of recovering metals as marketable products. Pyrometallurgical operations in authorized industrial scale facilities are distinct from unauthorized and illegal environmentally harmful practices in the informal sector.

Recycling: Relevant operations specified in Annex IV B to the Basel Convention (appendix II, section B, to this document).

Redeployment: Any action of new deployment or use by the owner of used computing equipment or its components.

Refurbishable: Computing equipment that can be refurbished, returning it to a working condition performing the essential functions it was designed for.

Refurbishment: Modification of used computing equipment to increase its performance and functionality or to meet applicable technical standards or regulatory requirements, including through such activities as cleaning, data sanitization and software upgrading.

Repair: Fixing specified faults in computing equipment and/or replacing defective components of computing equipment to bring the computing equipment into a fully functional condition.

Reuse: The using again, by a person other than its previous owner, of used computing equipment or a functional component from used computing equipment that is not waste for the same purpose for which it was conceived, possibly after refurbishment, repair or hardware upgrading.

Separation: The removal of specific components (e.g., batteries), constituents or materials from computing equipment by manual or mechanical means.

Small and medium-sized enterprises (SMEs): According to the European Commission, small and medium-sized enterprises are those businesses that employ fewer than 250 persons and have an annual turnover not exceeding 50 million euros or an annual balance sheet total not exceeding 43 million euros.

Testing: The testing of used computing equipment through an established protocol to determine whether it is suitable for reuse.

Transport of dangerous goods recommendations: United Nations recommendations on the transport of dangerous goods, which deal with classification, placarding, labelling, record keeping and other matters relating to the protection of public safety during the transport of such goods.

Treatment: Any physical, chemical or mechanical activity in a facility that processes computing equipment, including dismantling, removal of hazardous components, material recovery, recycling or preparation for disposal.

Upgrading: Modification of fully functional computing equipment by the addition of software or hardware to increase its performance and/or functionality.

Used computing equipment: Computing equipment that is or has been used, either by its first owner or otherwise. Used computing equipment may or may not be a waste, depending upon the waste definition and its characteristics, intended destination and fate.

Wastes: Substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law (paragraph 1 of Article 2 of the Basel Convention).

Working condition: See Fully functional.

Appendix

Examples of international conventions, regional agreements and national legislations and other regulatory frameworks

International conventions and regional agreements

Basel Convention	http://www.basel.int/
Stockholm Convention	http://chm.pops.int/
Rotterdam Convention	http://www.pic.int/
Regional Agreements regarding transboundary movements (export, import, transit) of used and waste computing equipment	<ul style="list-style-type: none">– Waigani Treaty: Bans the exporting of hazardous or radioactive waste to and from Pacific Islands Forum countries– Bamako Convention: Treaty of African nations prohibiting the import of any hazardous wastes (including radioactive)– Izmir Protocol: Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and their Disposal– Central American Accord: Regional agreement to control the trans-boundary movement of hazardous wastes and prevent the illegal traffic and disposal of such wastes in Central America

Legislation on ESM of used and waste computing equipment

Argentina	<p>National Legislation:</p> <ul style="list-style-type: none">– Resolution Secretary of Energy 48/2015: Approval of the General Regulations of the stimulus program called RENOVATE (Program for Promotion of Production and Marketing of Household Electric Appliance Energy Efficient) in force at December 31, 2015 http://www.infoleg.gob.ar/infolegInternet/anexos/245000-249999/245470/norma.html <p>Autonomous City of Buenos Aires:</p> <ul style="list-style-type: none">– Law 2807 and decree 70572011: establishes measures for the management of used electronic devices http://www.buenosaires.gob.ar/areas/leg_tecnica/sin/normapop09.php?id=120229&qu=c&ft=0&cp=&rl=1&rf=&im=&ui=0&printi=1&pelikan=1&sezion=1094565&primera=0&mot_toda=&mot_frase=&mot_alguna= <p>Provinces:</p> <ul style="list-style-type: none">– Law 14321 Decree 2300/11 Province of Buenos Aires: establishes guidelines, obligations and responsibilities for the sustainable management of Waste Electrical and Electronic Equipment (WEEE) http://www.gob.gba.gov.ar/legislacion/legislacion/l-14321.html– Law 9737 Province of La Rioja: Recycling Program of WEEE http://www.residuoselectronicos.net/wp-content/uploads/2013/07/Novedades-Normativas-28-de-junio-de-2013-2-2.pdf– Law 56 Province of Chubut: Recycling Program of WEEE http://www.rezagos.com/downloads/Ley_N_7345_-_RAEE_-_Chaco.pdf– Law 8362 Province of San Juan: general framework for the management of used EEE and WEEE http://www.legislaturasanjuan.gob.ar/index.php/prensa/item/3222-ley-n-8362– Law 7345 Province of Chaco: program and regulation for the management of WEEE http://200.41.235.179:83/index.php?option=com_content&view=article&id=1228:ley-7345-chaco-poder-legislativo&catid=600&Itemid=477
Chile	<p>Diario Oficial Establece Ley Marco 20.920 de residuos http://www.residuoselectronicos.net/?p=4384</p>
Colombia	<p>Ley N° 1672 sobre gestión integral de residuos de aparatos eléctricos y electrónicos http://www.residuoselectronicos.net/?p=4086</p>

EU	<ul style="list-style-type: none"> - Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE), http://ec.europa.eu/environment/waste/weee/legis_en.htm - Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS), http://ec.europa.eu/environment/waste/rohs_eee/legis_en.htm - Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipment of waste, http://ec.europa.eu/environment/waste/shipments/legis.htm
Madagascar	<ul style="list-style-type: none"> - Decree N°2012-753 of 07/08/12, relating to the prohibition of the import of wastes within the Basel convention frameworks - Decree N° 2012-754 of 07/08/12 establishing the end of life-product management procedure, wastes and hazardous waste environmentally harmful generator, within the Basel convention implementation - Decree No. 2015-930 of 06/09/15 establishing Classification And Environmentally Sound Management of Electrical Electronic Equipment (WEEE) in Madagascar
Peru	<ul style="list-style-type: none"> - Reglamento Nacional para la Gestión y Manejo de los Residuos de Aparatos Eléctricos y Electrónicos, 2012 Ministerio del ambiente N° 2012-16354 http://www.raee-peru.pe/index.php/reglamento-nacional-raee-1
Slovak Republic	<ul style="list-style-type: none"> - Law on waste 79/2015 (e-waste is mentioned in Section 2) - Secondary legislation on e-waste 373/2015
Switzerland	<ul style="list-style-type: none"> - Ordinance on the return, the take back and the disposal of electrical and electronic equipment (ORDEE) SR 814.620; available in German, French and Italian language; see below. Verordnung über die Rückgabe, die Rücknahme und die Entsorgung elektrischer und elektronischer Geräte (VREG) SR 814.620 http://www.bafu.admin.ch/abfall/01472/01478/index.html?lang=de Ordonnance sur la restitution, la reprise et l'élimination des appareils électriques et électroniques (OREA) SR 814.620 http://www.bafu.admin.ch/abfall/01472/01478/index.html?lang=fr Ordinanza concernente la restituzione, la ripresa e lo smaltimento degli apparecchi elettrici ed elettronici (ORSAE) SR 814.620 http://www.bafu.admin.ch/abfall/01472/01478/index.html?lang=it
General data base	<ul style="list-style-type: none"> - ECOLEX, the gateway to environmental law: http://www.ecolex.org/start.php

Technical guidelines, guidance documents and technical directives

Basel Convention (PACE)	<ul style="list-style-type: none">– Guidance document on the environmentally sound management of used and end-of-life computing equipment, adopted (except section 3) at COP11 in 2013 (document UNEP/CHW.11/6/Add.1/Rev.1), http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/PACE/PACEGuidanceDocument/tabid/3246/Default.aspx– Guideline on environmentally sound testing, refurbishment and repair of used computing equipment;– Guideline on environmentally sound material recovery and recycling of end-of-life computing equipment;– Report with ESM criteria recommendations http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/PACE/PACEGuidelinesandGlossaryofTerms/tabid/3247/Default.aspx– Manual on Steps to Establish and Implement Environmentally Sound Management for Used and Waste Computing Equipment– Report on project experiences and lessons learned
Basel Convention (technical guidelines)	<ul style="list-style-type: none">– Technical guidelines on transboundary movements of electrical and electronic waste and used electrical and electronic equipment, in particular regarding the distinction between waste and non-waste under the Basel Convention, Adopted, on an interim basis, at COP 12 in May 2015– Advance version - document UNEP/CHW.12/5/Add.1/Rev.1: http://www.basel.int/Implementation/TechnicalAssistance/Partnerships/PACE/PACEGuidelinesandGlossaryofTerms/tabid/3247/Default.aspx
Peru	<ul style="list-style-type: none">– Norma Técnica Peruana NTP 900.064, 2012: Gestion Ambiental. Gestión de residuos. Manejo de residuos de aparatos eléctricos y electrónicos. Generalidades, Peru– Norma Técnica Peruana NTP 900.065, 2012: Gestion Ambiental. Gestión de residuos. Manejo de residuos de aparatos eléctricos y electrónicos. Generación, recolección interna, clasificación y almacenamiento. Centros de acopio., Peru
Switzerland	<ul style="list-style-type: none">– Technical guidelines for the disposal of waste electrical and electronic equipment, SENS and SWICO, Switzerland. Available in French and German language; see below Prescriptions techniques pour la récupération des déchets d'équipements électriques et électroniques SENS et SWICO, Switzerland http://www.bafu.admin.ch/veva-inland/11827/11835/index.html?lang=fr Technischen Vorschriften zur Entsorgung von Elektro- und Elektronikgeräten SENS und SWICO, Switzerland http://www.bafu.admin.ch/veva-inland/11827/11835/index.html?lang=de

Additional resources and examples

UNEP/IETC	<ul style="list-style-type: none">– E-waste Volume III - WEEE/e-waste “Take back system”, August 2013– E-Waste Vol. 2: E-waste Management Manual, Dec 2007 (PDF 2.2MB)– E-Waste Vol. 1: Inventory Assessment Manual, Dec 2007 (PDF 1.7MB)
UNEP	<ul style="list-style-type: none">– Sustainable Innovation and Technology Transfer Industrial Sector Studies– Recycling – From E-Waste to Resources. <p>http://www.unep.org/pdf/pressreleases/E-waste_publication_screen_finalversion-sml.pdf</p>
UNU-IAS	<ul style="list-style-type: none">– E-waste statistics: guidelines and classification, reporting and indicators <p>http://i.unu.edu/media/unu.edu/news/49515/E-waste-Guidelines_Partnership_2015.pdf</p>
Solving the E-waste Problem (step)	<ul style="list-style-type: none">– Solving the E-Waste Problem (step) Green Paper: Recommendations on Standards for Collection, Storage, Transport and Treatment of E-waste; Principles, Requirements and Conformity Assessment: http://www.step-initiative.org/files/step/_documents/StEP_GP_End%20of%20Life_final.pdf– Solving the E-Waste Problem (Step) White Paper: Recommendations for Standards Development for Collection, Storage, Transport and Treatment of E-waste http://www.step-initiative.org/files/step/_documents/StEP_WP_Standard_20140602.pdf– Step e-waste world map: http://www.step-initiative.org/step-e-waste-world-map.html
Plataforma RELAC	<ul style="list-style-type: none">– Lineamientos para la gestión de los Residuos de Aparatos Eléctricos y Electrónicos en Latinoamérica : Resultados de una Mesa Regional de Trabajo Público-Privado / Guidelines for the management of waste electrical and electronic equipment (WEEE) in Latin America: Results of a regional public-private round table http://www.residuoselectronicos.net/
Ministerio de Energía y Minería, Argentina	<ul style="list-style-type: none">– National Resolution Secretary of Energy 48/2015 establishes a system for the payment of financial compensation to the beneficiary entities Program Renovate: https://www.elclimalohacesvos.gov.ar/

IFIXIT	The free repair guide: https://fr.ifixit.com/
Project Econormas MERCOSUR	Sustainable Production and Consumption http://www.econormas-mercosur.net/es/pes
Microsoft Refurbisher Programs	Refurbished PCs http://www.microsoft.com/refurbishedpcs/programs.aspx
ITU's Connect 2020 Agenda	Goal 3: Sustainability: Target 3.2: Volume of redundant e-waste to be reduced by 50% by 2020 http://www.itu.int/en/connect2020/Pages/default.aspx

