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PROTECTION OF CABLES AND OTHER ELEMENTS OF
OUTSIDE PLANT

Life-cycle management of ICT goods

ITU-T L-series Recommendations – Supplement 5

ITU-T

Supplement 5 to ITU-T L-series Recommendations

Life-cycle management of ICT goods

Summary

Supplement ITU-T L.Suppl.5 has been developed to provide information for the practical implementation of the life-cycle approach in companies, facilities and plants as well as distributors, including chapters on best practices with a specific focus on material usage and selection.

The information on facilities and the different stakeholders includes:

- ICT product design issues, supplementing international standard IEC 62430 on environmentally-conscious design for electrical and electronic products, with a focus on practical implementation;
- ICT life-cycle approach to address health, environment and socio-economic aspects including avoiding hazardous emissions from uncontrolled disassembly, burning or disposal of e-waste, occupational health and involvement of the informal sector;
- reduction of the end of life impact through technical guidance applicable to refurbishment and repair facilities;
- reuse and end of life management;
- marketing of used ICT goods, including risk prevention, minimization measures and eco-environmentally sound processing;
- donation of ICT goods, including quality control for donated equipment, technical support in the country of destination, following international procedures on transparency and documentation of contracts, notifications and consent prior to delivery;
- management of equipment and components destined for reuse.

History

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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Table of Contents

		Page
1	Scope.....	1
2	Definitions	1
3	Abbreviations and acronyms	1
4	ICT goods covered by this Supplement.....	2
5	Material selection for products	2
	5.1 Resource efficiency	2
	5.2 Design for resource efficiency.....	2
	5.3 Resource efficiency indicators in life cycle assessment.....	3
	5.4 Eco-environmentally informed material choices.....	4
	5.5 Primary and secondary material usage in production.....	4
	5.6 Closed and open cycles	6
6	Transport and packaging.....	7
7	ICT product usage.....	7
	7.1 Material use for product maintenance	7
	7.2 Energy consumption.....	7
8	End of life treatment	7
	8.1 Used ICT goods collection	7
	8.2 Reuse	10
	8.3 Recycling.....	15
	8.4 Waste treatment	22
9	Impact of ICT waste on developing countries and countries with economies in transition	26
	Appendix I – Sourcing of materials	27
	Appendix II – Used mobile phones collection in Korea.....	33
	Appendix III – Good practice case studies of donation, refurbishment and reuse of used ICT equipment.....	35
	Appendix IV – Future work on energy consumption	36
	Appendix V – Recommendations for battery testing.....	38
	Appendix VI – Labeling and documentation of refurbished and repaired ICT equipment	40
	Appendix VII – Example of product handling and refurbishment of mobile phones.....	41
	Appendix VIII – Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.....	45
	Bibliography.....	46

Supplement 5 to ITU-T L-series Recommendations

Life-cycle management of ICT goods

1 Scope

This Supplement provides information for the practical implementation of the life-cycle approach in companies, facilities and plants as well as distributors, including chapters on best practices with a specific focus on material usage and selection.

2 Definitions

This Supplement uses the following terms:

2.1 pre-consumer material: Material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

2.2 post-consumer material: Material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.

2.3 recovered and/or reclaimed material: Material that would have otherwise been disposed of as waste or used for energy recovery, but has instead been collected and recovered and/or reclaimed as a material input, in lieu of new primary material, for a recycling or a manufacturing process.

2.4 recycled content: Proportion, by mass, of recycled material in a product or packaging. Only pre-consumer and post-consumer materials should be considered as recycled content.

2.5 recycled material: Material that has been reprocessed from recovered [reclaimed] material by means of a manufacturing process and made into a final product or into a component for incorporation into a product.

3 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

BFR	Brominated Flame Retardants
BOF	Basic Oxygen Furnace
CO ₂	Carbon Dioxide
DfE	Design for Environment
DfR	Design for Recycling
DfRE	Design for Resource Efficiency
EAF	Electric Arc Furnace
EPR	Extended Producer Responsibility
ESM	European Stability Mechanism
ICT	Information and Communication Technology
LCA	Life Cycle Assessment
ME	Material efficiency
PCB	Printed Circuit Board

WEEE	Waste Electrical and Electronic Equipment
WLAN	Wireless local area network

4 ICT goods covered by this Supplement

The Supplement addresses mainly the following equipment:

- Cellular radio base stations
- Fixed access network (for Internet services)
- WLAN
- Routers
- Business telephony equipment
- Mobile phones
- Personal computers and laptops
- Scanners, printers and peripherals
- For more examples see [b-ITU-T L.1410]

5 Material selection for products

5.1 Resource efficiency

Resource efficiency is about the optimization of selection, use, reuse and recycling of materials throughout the product life cycle.

$$ME = \frac{\text{Economical benefit}}{\text{Impact from material extraction, usage and end of life treatment}}$$

The equation for material efficiency (ME) is derived from the eco-efficiency definition in [b-ISO 14045]. It includes the optimal use of materials across the product lifecycle and value chain starting from raw material extraction and conversion, product design and manufacture, transportation, use and re-use ending to recovery, disposal or recycling. This total life cycle approach of resource efficiency also includes the energy needed to create a certain material. The opportunities to improve the resource efficiency of a product are not limited to a certain stage of the lifecycle and improvements at one stage can have a significant impact on another.

The "Economical benefit" describes the positive impact from the usage of the material in a certain product and its resulting services. The usage of a certain material might improve the performance and hence value of a product considerable compared to an alternative material.

Resource efficiency basically means that "more is achieved with less". In this way a smaller amount of material is needed to produce a product and raw materials are kept in use for a longer time once they have been extracted. Improvement in resource efficiency is a constant objective of companies as they strive to improve their economic and financial performance (cost reduction and increased competitiveness). Increase in resource efficiency may come from raw materials production, product manufacturing, use and/or end-of-life.

Proper product design, material selection and using of recycled material are means to improve resource efficiency. Full product lifecycle needs to be considered to get the full impact from materials.

5.2 Design for resource efficiency

There are already approaches for design for environment (DfE) (also terms environmentally conscious design (ECD) and eco-design are used) and design for recycling (DfR). Recently design for resource efficiency (DfRE) has received increasing interest. Depending on the definition, resource

efficiency can retain raw material consumption only, or the consumption and pollution of natural resources. Resources are not only an eco-environmental concern, because raw material availability is a critical issue for many industrial sectors. Design for environment blends eco-environmental aspects into product design and development to enhance environmental performance throughout the product's lifecycle.

Design for environment can be roughly divided into development work, which seeks new, more eco-environmentally aware basic technical solutions (e.g., materials, processes, structures, manufacturing methods). Design for environment could include many research features, and activities aiming to reduce the adverse eco-environmental impacts of existing structures and basic solutions.

Design for recycling is an important sector of design for environment. It aims to facilitate and increase after use recycling and enable other ways of utilizing components. Design for recycling is a method that implies the following requirements of a product: easy to dismantle, easy to obtain 'clean' material-fractions, that can be recycled (e.g., iron and copper should be easy to separate), easy to remove parts/components, that must be treated separately, use as few different materials as possible, mark the materials/polymers in order to sort them correct, avoid surface treatment in order to keep the materials 'clean'.

Resource efficiency pursues three objectives:

- reducing eco-environmental impacts,
- improving material supply security including lowering import dependency e.g., for metals,
- saving costs in production.

The necessity of sustainable use of raw materials is widely accepted, but there is no consensus on how material use should be measured. This measurement can be made based on definition of physical indexes such as mass and material input per service unit, or mid-point impact assessment indicators of Life cycle assessment (LCA) such as mineral resource depletion or fossil fuel depletion. From the perspective of life cycle based sustainability assessment, DfR approaches are not always sustainable, because they only look at the output side of a product and try to make it easy to deal with the waste at the end-of-life. From a sustainability perspective, it is necessary to look at the input side, e.g., how much of these materials actually replace virgin materials. Sometimes recycling increases overall eco-environmental burdens and resource demands.

Weight reduction is a critical objective in design for resource efficiency in any product. It reduces the cost of manufacture, installation and logistics, saves materials and energy and there is less material to be recycled or disposed of at the end of product's life. System miniaturization has been a long-time trend in the electronics industry.

5.3 Resource efficiency indicators in life cycle assessment

LCA is based on life cycle thinking which means taking into account the whole life cycle of the product. This begins from raw material extraction and conversion, continues to manufacturing, distribution and use. The life cycle ends with so called end-of-life stage, including re-use, recycling of materials, energy recovery or disposal. The core of life cycle thinking is to avoid eco-environmental burden shifting. This means minimizing impacts at one stage of the life cycle, or in one eco-environmental impact category, while avoiding increases elsewhere. [b-ITU L.1410] defines the attributional LCA method in detail for ICT goods.

In the LCA study impact assessment phase, some parts of the inventory are classified into selected mid-point eco-environmental impact categories as shown in Figure 1.

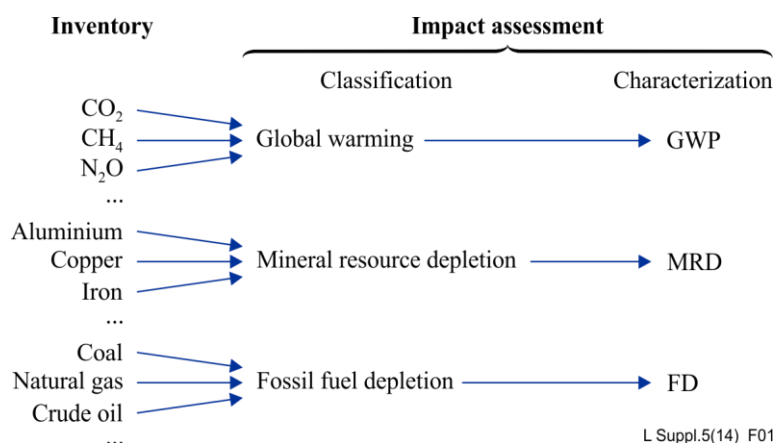


Figure 1 – Example framework of the impact assessment steps and impact categories at the mid-point level

In design for resource efficiency three impact categories are very important for Telecom goods: climate change, mineral resource depletion and fossil fuel depletion.

5.4 Eco-environmentally informed material choices

The engineering properties of materials, i.e., their mechanical, thermal and electrical attributes, are well characterized. They are measured with sophisticated equipment according to internationally accepted standards. Additional metrics are needed to incorporate eco-environmental objectives into the design process.

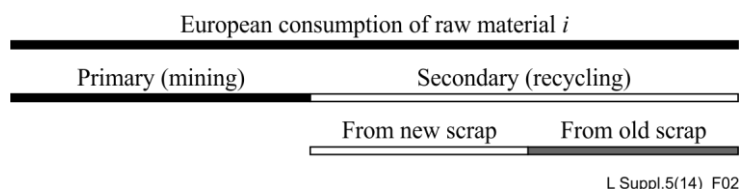
In Table 1, three example eco-environmental attributes of materials are presented. Recycled material content is one attribute, because enhancing the recycled material content when producing new raw materials is important. The main eco-environmental impacts of enhancing recycled material content are to reduce mineral resource usage and also reduce fossil fuel depletion. The next eco-environmental attribute embodied energy means primary energy (renewable and non-renewable) used in making one kilogram of material. The environmental impact of minimizing embodied energy is fossil fuel depletion. The third eco-environmental attribute is carbon dioxide (CO₂) equivalents which refers to climate change environmental impact and is closely connected to embodied energy.

Table 1 – Example eco-environmental attributes of materials

Eco-environmental attribute	Eco-environmental impact
Recycled material content	Mineral resource and fossil fuel depletion
Embodied energy	Fossil fuel depletion
CO ₂ -equivalents	Climate change

5.5 Primary and secondary material usage in production

The raw material production of metals can make use of a combination of primary and secondary sources and both pathways need to be understood as complementary. Whether the recycled metals are used in the same product group or in another application does not really matter, since both primary and secondary metals are traded on a global scale and any quantity of recycled metal directly impacts its demand supply balance. For most metals their recycling does not lead to deterioration in quality, meaning that in theory such cycles could continue forever.

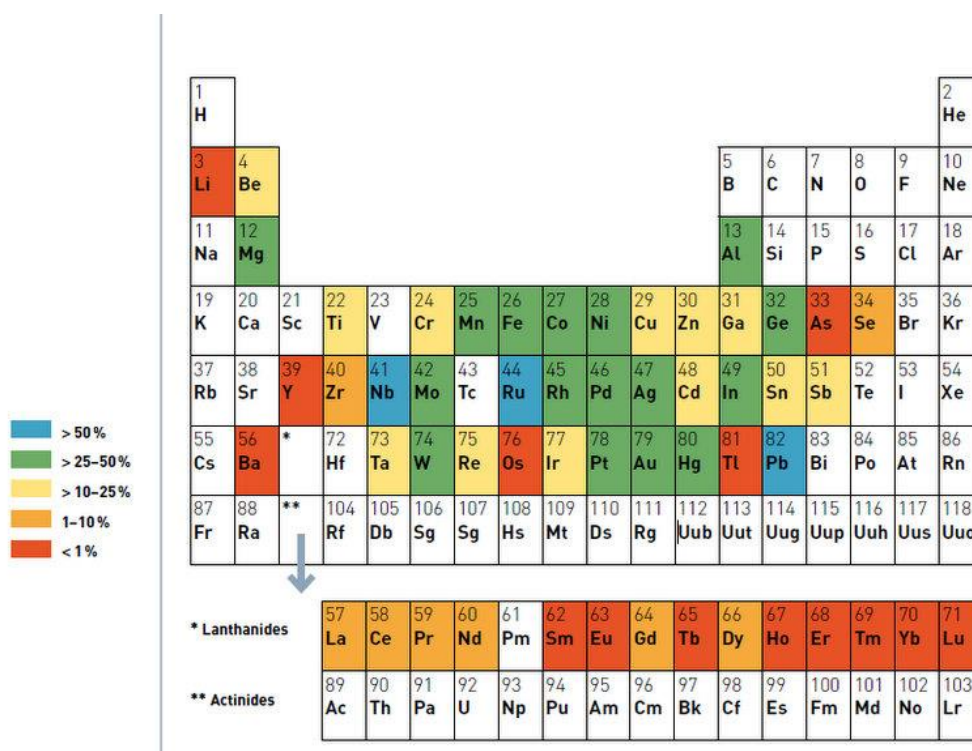


(Source: European Commission 2010)

Figure 2 – Materials recycled content rate

In Figure 2, new scrap refers to scrap resulting from the processing of raw material from primary sources and old scrap refers to raw material which has been recycled at the of the life products.

The new scrap availability depends on the degree of metal use and the process efficiency in manufacturing. The old scrap availability is a function of metal use a product lifetime ago, in use loss over the product lifetime and the efficiency of the end-of-life collection and recycling system. High growth rates in metal demand in the past, together with long product lifetimes, has resulted in availability of old scrap quantities being typically smaller than the metal demand of production. Thus recycled material contents are smaller than 100%.



(Source: [b-UNEP])

Figure 3 – The periodic table of global average recycled content

The recycling content is in the total metal input to metal production for sixty metals. Boxes that are not coloured indicate that no data or estimates are available.

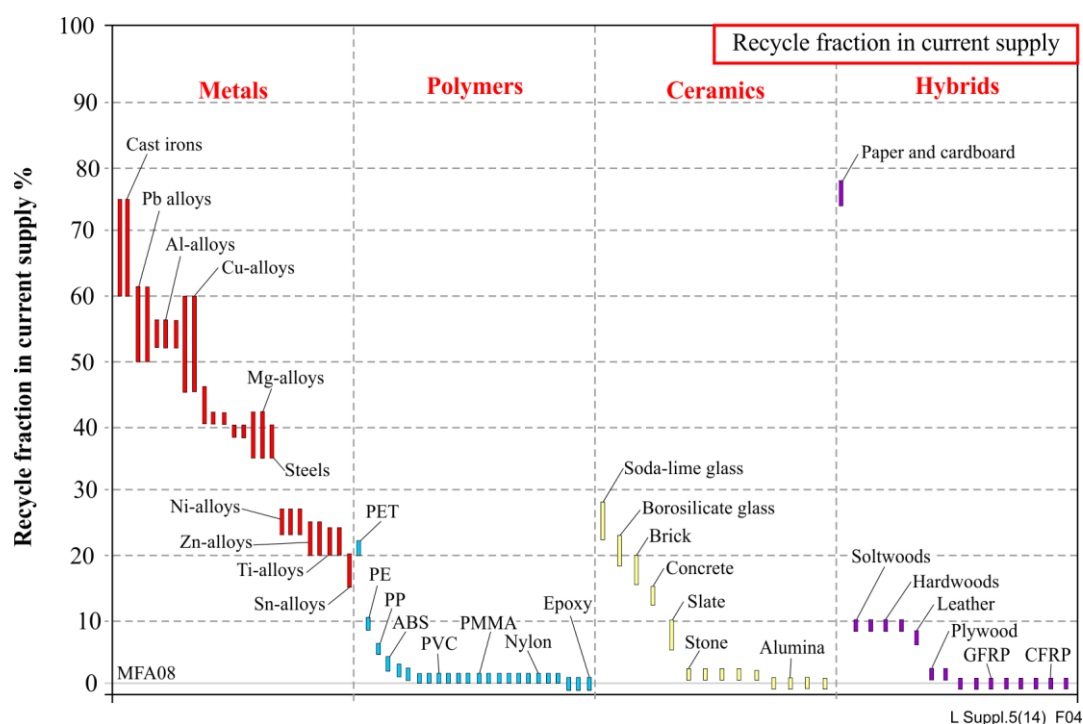
In Figure 3 the recycled content is over 50% only for lead (Pb), niobium (Nb) and ruthenium (Ru). The recycled content is between 25-50% for the most generally used metals such as iron (Fe) and aluminium (Al).

Recycling efficiencies can be improved based on the fact that material's cycles should be transformed from open to closed, or at least less open compared to the present situation. Open cycles are typical to many consumer goods such as cars, electronics and small appliances. Closed cycles are typical for

many industrial goods, such as machinery tools and process catalysts. Although the required recycling technology does not differ much from that for consumer goods, the recycling efficiencies are usually much higher due to a high awareness of involved stakeholders, economic recycling incentives, transparent and professional handling throughout the product life cycle, and a rather limited change of ownership and location of use.

There is generally no risk of geological depletion of raw materials. Industry's access to them could nevertheless be subject to a variety of other risks. The main issue concerns exploration and technological developments that will allow for a sustainable exploitation of resources rather than geological scarcity.

Figure 4 presents the data for recycle fraction in current supply. Recycling of metals is highly developed and its contribution to current supply is large. The same cannot be said of polymers. The community polymers are used in large quantities, many in products in short life, and they present major problems in waste management. However, the economics of polymer recycling is unattractive, with the result that their contribution to current supply is small.



(Source: [b-Ashby])

Figure 4 – Recycle fraction by chart

The recycled fraction that is referred to means the percentage of old scrap, together with the percentage of reutilization of materials, capable of being used within the same process that generated it.

5.6 Closed and open cycles

For many common basic metals it does not really matter whether the recycled metals are used in the same product group or in another application, since both primary and secondary metals are traded on a global scale and any quantity of recycled metal directly impacts its demand supply balance. And for most basic metals their recycling does not lead to significant deterioration in quality. These kind of open cycles are typical to many consumer goods such as cars, electronics and small appliances.

For plastics closed loop is usually a demand, because clean and sorted waste streams are needed for mechanically recycling of plastics.

The recycled content used when manufacturing materials depends on how much scrap is available. The new scrap availability depends on the degree of metal use and the process efficiency in manufacturing. The old scrap availability is basically depending on the efficiency of end-of-life collection system and recycling system. High growth rates in metal demand in the past, together with long product lifetimes result that availability of old scrap quantities are typically smaller than the metal demand in production and that hinders the use of old scrap usage in metals manufacturing. The recycled content used when manufacturing materials depends also on scrap's quality. Closed cycles that are typical for many industrial goods are a necessity that the scrap quality is good enough to be used in new material manufacturing. For many common basic metals the scrap quality is good enough also in open product cycles to be used in new material manufacturing.

Appendix I describes metals, plastics, and their recycled content in more detail.

6 Transport and packaging

Appropriate system boundaries and requirements for the transport of ICT goods is described in [b-ITU-T L.1410] and should be used for recycled goods accordingly.

7 ICT product usage

7.1 Material use for product maintenance

Material use for product maintenance is under study.

7.2 Energy consumption

The continuous increase of the number of ICT services, and the associated data traffic, offered by ICT networks, combined with the rise of the energy price, make the power consumption of ICT Goods one of the most important aspects to be taken into account.

Standards describing telecom network equipment power consumption measurements have been developed by ETSI, ITU-T for different types of ICT equipment and mobile networks. For example, see [b-ITU-T L.1310], [b-ETSI ES 201 554], [b-ETSI ES 203 136] or [b-ETSI ES 203 228].

The future activities information could be seen in Appendix IV.

8 End of life treatment

8.1 Used ICT goods collection

ICT goods that are discarded in household trash can cause severe eco-environmental impact, and is lost for further use. In some countries, informal scavengers may look at everything before it is finally discarded and used, and end-of-life computers often have enough value to be collected by them. This informal sector, however, must be transformed into a formal collection system, with standards and protections built in for everyone involved. Formal collection programmes frequently require significant effort and expense, and it may be necessary to find ways to subsidize collection systems in any country, in order to deliver computing equipment to environmentally sound management facilities for processing. Formal sector and governments should engage, employ, and empower the informal sector and help transition them into formal systems, which are consistent with applicable legal and other requirements including provisions that support protection of human health, worker safety and the environment.

Special collection events are often organized, or collection may be regularly on-going in retail stores, or by mail-in collection and also through consumers buy-back programmes. Charities sometimes collect computers for reuse. Collection of computers from large businesses provides an important

opportunity due to both the large volumes of equipment available from one source, and the fact that a lot of this equipment is retired early and thus has significant value in the refurbishment market.

Collectors should ensure equipment is handled, packaged and stored in such a way to avoid damage during transit. This may include the following concerns:

- Packaging fragile equipment to avoid damage during collection and transport;
- separating equipment to be assessed for reuse from waste to prevent contamination or damage of the reusable equipment;
- pack heavier items so that they do not move or fall on and damage lighter items;
- avoiding leakage from used printer toner;
- uninterrupted power supplies (UPS) may contain residual electrical charge and other batteries at risk for unintentional discharge or leakage;
- secure loads from unauthorized access to avoid confidential data being lost.

8.1.1 Collection systems

ICT goods should not be deposited into regular household waste, which would result in the equipment being disposed of in landfill or incinerated. ICT goods should be collected separately by the municipal waste collection system or an alternative waste collection system and Telecom operators and distributors can make a proportional contribution to raise users' awareness by informing and educating customers about potential eco-environmental impacts of equipment and to ensure that new and used ICT goods and accessories are responsibly managed throughout their life cycle.

As reuse or recycling value may drop quickly, users should be encouraged to avoid storing or setting aside unneeded ICT goods and to deliver them promptly to a collection system. However, if a collection system is not available or the collection point is not convenient, a user should hold the ICT goods in storage until the next opportunity arises to deliver it to a collection point.

A used ICT goods collection system should have collection points conveniently located for users so that they can bring their ICT equipment to such collection points. In addition, the collection system should be free of charge for users.

Collection of used ICT equipment through distribution channels (e.g., telecom operators, retailers or manufacturers) should be a key element of the collection system. Other collection methods may also be considered. In the case of collection by mail, postage may also be paid by the collection system, especially where a large number of used ICT equipment are being sent in a shipping package.

Collection systems for used ICT equipment should be accountable in a way that is practical and transparent to audit. This may require keeping a written record of the actual number of used mobile phones received, currently in storage, and shipped. Information about the reuse, recycling and final disposal of used ICT equipment and accessories is usually obtained directly from recycling and refurbishment companies.

8.1.2 Organization of collection points

Collection points must be an initial part of the collection system, which should also include appropriate facilities where evaluation and/or testing and labeling can be carried out to decide whether used ICT equipment destined for reuse are in working order and can be directly reused, or require repair, refurbishment or upgrading prior to reuse, or are to be sent for eco-environmentally sound material recovery and recycling.

In addition to collection points for consumers, it is important to consider collection from the repair sector, both formal and informal, to ensure that parts and ICT goods scrap do not end up in landfills. Such collection schemes could be undertaken by paying a price per kilogram of scrap collected and is likely to be funded from recoverable commodities.

Depending on the capacity available in particular countries and the logistics involved in managing used ICT equipment, the separate collection of used ICT equipment is recommended in order to preserve the working characteristics and resale value of those collected.

A collection point should ensure the security of the ICT goods collected. Where the collection point conducts a preliminary evaluation of potential for reuse, appropriate packaging material should be used to separate used ICT equipment from each another while in storage and during transportation to protect them from damage and to preserve their operational capability and market value for possible reuse. The type of material would depend on the availability of space at the point of sale.

Authorities should develop operating conditions and requirements that are uniquely applicable to used ICT goods collection systems, balancing any risks to human health and the environment against any perceived need for oversight and accountability.

8.1.3 Handling at the collection points

After preliminary evaluation, used ICT equipment which are destined for reuse should be packaged in such a way as to protect their integrity.

Whenever possible, used ICT equipment should be collected with their batteries, chargers and accessories. However, it should be noted that in some markets, phones, batteries and other accessories may be returned separately. It should be assumed that every battery retains some degree of electrical charge... If the batteries are removed, they should be packaged in such a way as to avoid contact with their terminals, to avoid short-circuits and fires. Batteries should be sent only to facilities that are specially qualified to recycle or process batteries for materials recovery, and should be protected against extremes of temperature. Care should be taken to ensure that the transportation of batteries complies with all applicable regulations or courier requirements, i.e., IATA regulations for the handling of lithium metal and lithium-ion batteries.

The collected used ICT equipment should be sent only to eco-environmentally sound facilities, having the relevant agreements for such activities, whether for intermediate accumulation, refurbishment and repair or for materials recovery and recycling.

8.1.4 Incentives for setting up collection systems

Consideration should be given to providing incentives to users to participate in a used ICT goods collection system.

Sellers of new ICT equipment should consider offering appropriate incentives for the collection of used ICT equipment when needed. Discounts on the purchase of new phones, free air time and free SMS are some of the possible incentives to be considered.

Manufacturers, telecom operators and ICT equipment ICT goods distributors should consider the possibility of sharing, as part of extended producer responsibility (EPR) systems, the physical and/or financial obligations entailed by the collection and management of used ICT equipment. This is particularly necessary and should be implemented as soon as possible in countries where the legislation and infrastructure for the collection of used ICT equipment is lacking.

Any financial mechanism established to hold and manage money collected either as a pre paid fee, advanced recycling fee (ARF), advanced disposal fee (ADF) or as a refundable deposit should be transparent to all concerned persons, including governments and the public.

If a direct and transparent fee is charged to the original buyer of an ICT equipment / ICT goods and the used ICT equipment / ICT goods is are exported for reuse, it may be necessary for some portion of that fee to follow the used ICT equipment / ICT goods to an importing country to provide for its eco-environmentally sound management there at the end of its life.

8.1.5 Optimizing capture of WEEE by existing collection points

To reduce theft in waste disposal facilities it is first of all to pursue financial operational measures (video surveillance / closed-circuit television systems, WEEE tracking, etc.).

A complementary action plan concerns the frequency of removal of WEEE in some big cities where collection rates are particularly low in waste disposal.

a) Improving the sorting of WEEE in waste collection facilities:

Beyond greater awareness of guards and employees in Waste collection facilities, a more precise characterization of scrap bins could be an interesting line of action to limit the impacts of errors in sorting waste disposal.

b) Reduce the "leaks" in distributors collection channel:

The introduction of a computerized system for better tracking WEEE stream taken in store, and especially delivery since they are dealing with the largest volumes, would better track the flows involved.

Faced with the rise of "pure players" among the distribution channels, it is necessary to ensure that they meet their obligation to return "one to one", with the implementation of effective solutions for the recovery, whether the delivery or recovery of small appliances (free postal return, etc.).

c) Improve the WEEE sorting in households:

Finally, a significant part of the deposit still remains poorly sorted by households. This mainly small WEEE are sometimes discarded with household waste. These quantities can certainly be further reduced through awareness and education of households to new practices (to be effective, communication must be based on specificity of the collection scheme).

8.2 Reuse

8.2.1 Processing and management of equipment and components destined for re-use

This section addresses the environmentally sound management of ICT equipment ICT goods that are accepted by a refurbishment organization for refurbishment and/or repair. The best possible outcome for any device accepted by a refurbisher is for that equipment to be reused either as designed or purposed.

Recent advances in computer operating system (OS) software require significantly less "computing power" than previous OSs. If computing equipment is not appropriate for general use it may have another life as a single task system, such as a print server or file server, or be completely repurposed for a task such as monitoring the electrical grid.

The physical life of the equipment is significantly longer than that of software. Care should be taken to differentiate between software problems (that are typically correctable) and hardware issues (that require greater expertise to correct).

When used ICT goods are refurbished or repaired, any hazardous substances, or parts containing hazardous substances that are being replaced, consideration should be given to replace them with readily available parts containing benign substitutes (nonhazardous) and in line with national legislations, and regional and international conventions prescribing phase out strategies. Discarded or broken parts and hazardous materials should be handled as described in clause 8.4.

8.2.2 Testing of equipment and components (hardware) prior to reuse to ensure full functionality

a) Used ICT equipment

Facilities should undertake an initial sorting of ICT equipment and components in order to identify and separate that which has potential for reuse as a whole or for re-use of parts, from equipment that should be recycled.

Refurbishment facilities should accept only equipment that they are prepared to reuse/refurbish or send to an eco-environmentally sound material recovery operation. Personnel must be trained to handle equipment that can be fully processed.

The following functionality tests are proposed for used ICT equipment to confirm that the equipment is fully functional and is suitable for re-use (see Figure 5).

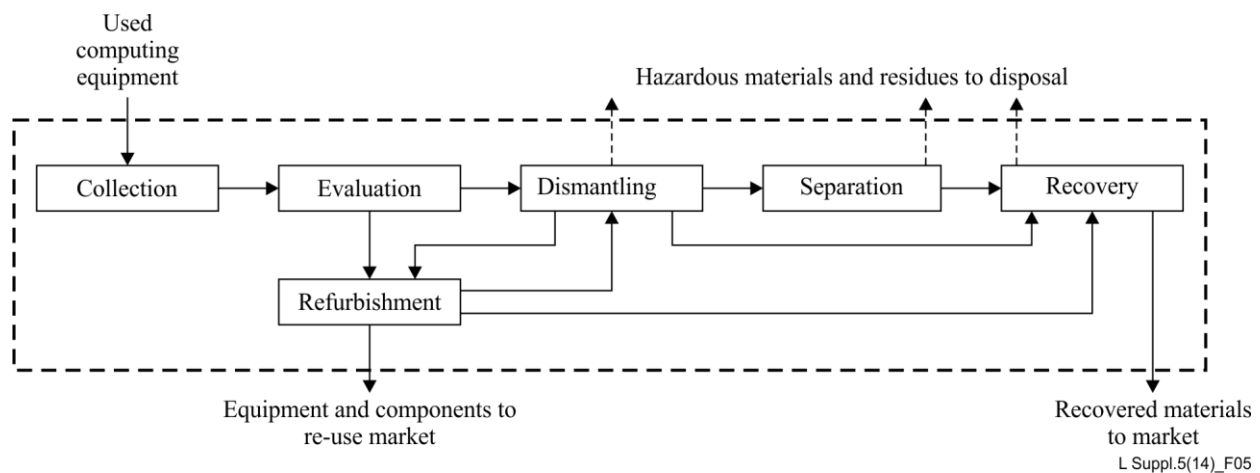


Figure 5 – Flow diagram of environmentally sound management of used computing equipment [b-PACErr]

b) Batteries

It is important to note that there are a wide variety of battery sizes, capacities and technologies currently in use in computing equipment, although almost all new laptop batteries are of lithium-ion type with some older laptops based on nickel metal hydride or occasionally nickel cadmium (Ni Cd). While this section is concerned with the assessment of laptop batteries, it is worth noting that there are also other multiple uses for batteries in computing equipment, such as small button cell batteries that are attached to circuit boards, and additional batteries that are used in devices such as wireless keyboards and mice. There are also battery back-up systems in use in some countries to provide an uninterrupted power supply, and which provide emergency power to desktop computers when the principal power source fails. In contrast to the batteries used in the actual computing equipment, these electricity supply back-up system batteries are typically lead-acid.

A used laptop battery's current charge capacity relative to its original capacity can provide important information for the user or refurbisher because over time, the capacity of a battery to hold charge deteriorates. A battery's current capacity can be measured as a percentage of the amount of charge the battery was able to hold when new.

See Appendix V for more details on battery re-use.

8.2.3 Final testing

Final testing should be conducted by the refurbisher after the computing equipment has been refurbished or repaired to full functionality and is ready for reuse, and prior to sale, donation or export for reuse. Final testing of computing equipment and newly installed software should ensure the device