Erasmus+

LaWEEEda

Latin American-European network on waste electrical and electronic equipment research, development and analyses

D4.2 Report on adaptation of CPD educational products

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Project Coordination:

University of Natural Resources and Life Sciences, Vienna

European Partners:

Hamburg University of Technology

University of Northampton

Latin-American Partners:

Local Coordination in Brazil:

UFRJ

Local Coordination in Nicaragua:

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Table of contents

1. Introduction

Within course of the project “Latin America-European network on Waste Electrical and Electronic Equipment, research, development and analysis” (LaWEEEda) modern and high quality modules, courses and educational products will be developed. These educational products are especially tailored for Nicaragua and Brazil and include both academic education and continuing professional development (CPD) training courses in the area of WEEE management and related entrepreneurial skills.

The report D4.2 focuses on the existing materials for CPD training which has been changed, adjusted, and tailored in order to fit the goals of the laWEEEda Project and respond to the specific needs of the Nicaraguan and Brazilian project partners.

2. Selection of relevant modules, courses and educational products for CPD

The idea in the CPD courses according to WP4 is to block courses due to other obligations of practitioners. It is intended to provide courses, in which the duration is not exceeding two consecutive working days. A special challenge in CPD is the heterogeneity of target groups ranging from dismantling plant managers to people involved in practical dismantling. Therefore, the practical dismantling modules can be selected according to its WEEE content specifics. The provided teaching content for CPD courses will be divided in three modules

- Module 1 - WEEE management | Key principles in e-waste management,
- Module 2 - WEEE management | Business planning and entrepreneurship in the field of e-waste and
- Practical dismantling modules.

Module 1 and Module 2 of the CPD courses contain the content of the academic courses Modules 2 and 3 (see above) yet in a condensed and adapted form. Thereby the workload in teaching hours per semester is reduced, so that both Modules end up with in total 14 teaching hours. The practical dismantling modules will cover 7 teaching hours each.

2.1. Module 1 – Key principles in e-waste management

The major goal of Module 1 is to provide adequate information about the key principles in e-waste management. As each of the modules provided in the frame of CPD has two days duration, it is quite challenging to provide each lecture number in this very condensed form. Yet the contents are developed within the LaWEEEda project, but of course in "real-life" implementation the modules are flexible in terms of containing lectures and therefore contents could be changed / switched / deepened depending on special wishes of participants. The detailed description of contents can be found in Module 1of the academic courses, but outlined again in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

Table 1 – Content of CPD Module I - WEEE management | Key principles in e-waste management

Lecture number	Chapter	Main Content	Workload (teaching hours / seme.)
1.1	Policy and legislation for e-waste	Key principles: International aspects (e.g. Basel Convention etc.); European examples, Brazilian / Nicaraguan specifics. The chapter contains policies, strategies and regulations necessary for the successful shaping of the waste management system; extended producer responsibility, individual producer responsibility.	1.5
1.2	Sources and generation of e-waste	Correlation between WEEE generation and socio-economic situation, WEEE categories in the EU, WEEE generation in the EU and Latin America, challenges for proper WEEE management in Latin-American,	1
1.3	Reuse and repair	Reuse business models, repair - organisational setup, techniques, legal aspects (waste vs. product); warranty and liability issues of reusable electronic products, drivers for the reuse, the organisational setup for the repair, positive examples from the EU	1
1.4	Collection and take-back systems	Formal and informal collection systems, legal framework, types of collection schemes, difference between extended producer responsibility and environmental tax, prominent examples in the EU	1.5
1.5	Material composition of different WEEE categories	General material composition on the level of WEEE categories and specific devices, global reserves, production and application of based, precious and rare	2.5

Lecture number	Chapter	Main Content	Workload (teaching hours / seme.)
		earth elements, hazardous materials contained in the WEEE	

Lecture number	Chapter	Main Content	Workload (teaching hours / seme.)
1.6	De-pollution and dismantling	Basic requirements for the dismantling including special requirements for the facilities, tools and transport, depollution process, hazardous components in the most common electronic devices	1.5
1.7	Mechanical processing	Structure of the mechanical processing treatment, identification and explanation of the crashing, shredding, and granulation process, explanation of the separation processes: eddy current separator, magnetic separation, sink-flow separation	1
1.8	Specific treatment processes	Treatment procedure for Cathode ray tubes, flat panel displays, cables, lamps, printed circuit board treatment; mechanical, pyro- and hydrometallurgical processing of printed circuit boards; overview of the informal recycling technology; recycling of the plastics from WEEE	1.5
1.9	Final treatment - recycling	Ferrous metal, aluminium and copper production process	1
1.10	Final treatment - disposal	Hazardous wastes, waste for disposal: Technologies, impacts etc., storage; disposal of WEEE in the global context; overview of the state-of-the-art landfill technology	1.5
		Total:	**14**

2.2. Framework for the Module 1

Topic 1.1 Policy, Legislation and best practice

To pass the topic they need to know….	• Existing laws (international, national, regional, municipal), policy and strategy • The institutions that regulate • Actual situation and how to apply (public and social awareness, best practice)
To put their knowledge to use they will need skills (and knowledge) in….	• Dominating the written materials and oral information provided in the course as well as knowledge how to acquire and how to update knowledge • How to interpret and apply best practice in their situation • Knowledge of permit that are required and processes to obtain them
We will know they have learnt because we will assess them by	• Group exam to develop the problem and present the solution publicly • Individual / multiple choice exam • *Scenario -Identification of specific law / policy and how it impacts on them*

Topic 1.2 Sources and generation of e-waste

To pass the topic they need to know….	• Types of EEE and WEEE • EEE producers, retailers, consumers *B2B, B2C* • WEEE collection points *types, locations etc* • Lifespan profiles of EEE • Statistical data on WEEE generation/ EEE consumption and production • WEEE generation estimation and methods
To put their knowledge to use they will need skills (and knowledge) in….	• Read and write, and analytical ability • Techniques for information search • Basic computer skills • Basic mathematics • Basic knowledge on EEEE/WEEE market chains • *Assessment of B2B vs B2C quality implications*

We will know they have learnt because we will assess them by	• Case study –
	  ○ analytical ability to describe and analyse market chain
	  ○ analyse statistical data
	  ○ collect data and produce charts
	  ○ make basic calculations
	• Theorectical tests
	  ○ True false tests
	  ○ Multiple choice
	  ○ Fill in tests
	  ○ Brief description

Topic 1.3 Reuse and repair

To pass the topic they need to know….	• Practical solutions • How to choose the most appropriate business model • Know how on composition of reuse / repair sector • Required legal aspects such as environmental licences, by laws etc • Requirements for commercial confidentiality and data protection • Identify materials/ products suitable for repair / reuse (rather than recycling)
To put their knowledge to use they will need skills (and knowledge) in….	• separate waste from products • appropriate tools and equipment to use • identification of valuable, hazardous etc components • Plan and calculate using software • Basic quality control methods • *Assessment of reuse potential ie when beyond repair*

We will know they have learnt because we will assess them by	• Simulating a business/ workshop/ warehouse that includes:
	  ○ Choosing an appropriate business plan
	  ○ Process and classify two materials
	  ○ Peer review from other students

Topic 1.4 Collection and take back systems

To pass the topic they need to know….	• What is the difference between formal and informal sector • Who are the WEEE formal and informal actors and what are their roles? • What are the legal and contractual requirements? • Possible take back channels • Collection optimisation – containers, routes, logistics etc • *Voluntary and statutory agreement/requirements*
To put their knowledge to use they will need skills (and knowledge) in….	• WEEE sources and types • Basic computer skills • Basic understanding of WEEE market and shape ie recycling • Basic maths to understand arket prices and values • Hazardous waste destinations and costs

We will know they have learnt because we will assess them by	• Theoretical tests
	• Case study
	  ○ Analyse current situation
	  ○ Identify areas for improvement

Topic 1.5 Material composition of different WEEE categories

To pass the topic they need to know….	• Types of materials, components etc plastics, different metals etc • Identification of hazardous and valuable aspects • Understanding of different values
To put their knowledge to use they will need skills (and knowledge) in….	• Knowledge on waste classification • Ability to use tools • Identification and use of appropriate protective equipment
We will know they have learnt because we will assess them by	• Workshop to evaluate simulated real life situations where materials are separated and classified, identify hazards, identify valuable materials - whilst using correct protective equipment. • *Development of breakdown protocol for specified product*

Topic 1.6 Depollution and dismantling

To pass the topic they need to know….	• Different categories of WEEE and the major components- their value and risks • Optimisation of dismantling for reuse • Identify end of life routes for the different parts from the dismantling process
To put their knowledge to use they will need skills (and knowledge) in….	• Technical knowledge on materials and risks • Appropriate disassembly operations • Identification of protective equipment
We will know they have learnt because we will assess them by	• Case study of specific product – disassembly – tools, products, risks, markets

Topic 1.7 mechanical processing

To pass the topic they need to know….	• What are the essential mechanical processes and technologies?
	  ○ What capacity, efficiency?
	  ○ Operational processes?
	  ○ What materials?
	  ○ Risks, health and safety, PPE etc
	  ○ troubleshooting
	• Outputs – quality/ standards/ rejects
	• Process combinations for efficient material flow
	• How to control input / output flows and performance – mass balance

To put their knowledge to use they will need skills (and knowledge) in….	• Machine and WEEE pairing – best machine for WEEE and vice versa • Correct PPE choice • Correct operating procedures and associated safety processes • Ability to map current processes in a layout • Optimise process flows and layouts • Assess performance and develop convincing arguments • Understand market quality demands

We will know they have learnt because we will assess them by	• Theoretical test
	  ○ Understand risks / technologies
	  ○ Designed process flow and layout (reproduce and model)
	  ○ Undertake mass balance
	  ○ Define appropriate processes for each WEEE type
	• Practice
	  ○ Operate machines as designed utilising correct PPE and health and safety processes

Topic 1.8 specific treatment processes

To pass the topic they need to know….	• How to identify materials or WEEE, containing parts for which particular treatment processes apply
	• Identify and distinguish where to locate within the equipment materials to which specific treatment processes apply
	• Identify end of life solutions for material streams
	  ○ In company or external?
	  ○ Processes?
	  ○ Costs?
	  ○ Special restrictions / controls (storage, containers etc)?
	  ○ Overall cost analaysis – reject rates

To put their knowledge to use they will need skills (and knowledge) in….	• *Basic Cost benefit analysis* • *Basic life cycle analysis*
We will know they have learnt because we will assess them by	• Scenario to test knowledge based on particular piece of equipment to identify parts that require special treatment and identify end of life treatment options.

Topic 1.9 Final treatment - recycling

To pass the topic they need to know….	• Classify different types of metals and plastics • Understand recycling process flows • Understand available technologies and their geographic / commercial availability • Evaluate costs and benefits of the principal recycling processes
To put their knowledge to use they will need skills (and knowledge) in….	• Manage and utilise identification and diagnostic devices • Undertake preliminary *process* analysis • Undertake calculations and determine financial viability • Identification and use of appropriate protective equipment • Identify equipment maintenance requirements • Pre-treatment requirements
We will know they have learnt because we will assess them by	• Scenario assessment – tutor provides a case study eg of a recycling plant – which student must analyse and suggest improvements

Topic 1.10 Final treatment - disposal

To pass the topic they need to know….	• Role of landfill for hazardous and non-hazardous waste • Role of thermal technologies – incineration, co-processing, advanced thermal technologies • Role of chemical treatments • Laws/ standards for hazardous material handling and storage, collection (procedures and equipment) country / area (urban, rural) • Identification of WEEE hazardous materials, impacts and risks • Potential recycling options • Emergency plans
To put their knowledge to use they will need skills (and knowledge) in….	• Identify and separate hazardous materials • Safe handling methods • Search market for available solutions • Understand impacts, materials at each step • Recommend appropriate treatment for different material types

We will know they have learnt because we will assess them by	• Theoretical test
	  ○ Identification of
	  ▪ laws and standards
	  ▪ types of materials
	  ▪ technologies
	• Case study
	  ○ Planning / disposal for a specified
	  ○ Gaps in standards / laws

2.3. Module 2 – WEEE management | Business planning and entrepreneurship in the field of e-waste

The main content of Module 2 regarding the CPD teaching courses builds up on the contents of Module 1 and puts special emphasis on business planning and entrepreneurship in the field of WEEE. This module is similar compared to the Module 3 of the academic courses, but more condensed. **Fehler! Verweisquelle konnte nicht gefunden werden.** displays the workload of the lectures in this module.

Table 2 - Content of CPD Module II - WEEE management | Business planning and entrepreneurship in the field of e-waste

Lecture number	Chapter	Main Content	Workload in teaching hours per semester
2.1	Financial aspects - Costs and markets	Costs by processes, markets by materials, revenues	2
2.2	Informal sector activities	Collection, typical treatment processes, emissions and impacts, integration strategies	1.5
2.3	Business plan development and entrepreneurship	Joint lecture with different disciplines, start-up planning, collection of entrepreneurial ideas in the field of e-waste, special focus: socio-economic enterprises	4
2.4	Plant layout	Examples of how to design various units in WEEE treatment plants	3
2.5	Reuse and repair	Reuse business models, repair - organisational setup, techniques, legal aspects (waste vs. product)	2
2.6	Laboratory and field tests	Material identification, laboratory analyses, composition analyses, pollutants, quality of secondary materials etc. mobile phones and notebooks	1.5
		Total:	**14**

2.4. Framework for the Module 2

Topic 2.1 Financial aspects – costs and markets

To pass the topic they need to know….	• Basic competency in accounts and financing • Knowledge and ability to manage the process costs during each phase as well as admin costs e.g.legal • Market insight including main products, vulnerabilities and strengths
To put their knowledge to use they will need skills (and knowledge) in….	• Applied mathematics • Negotiation • Sourcing costs of processing • Fiscal and subsidiary knowledge
We will know they have learnt because we will assess them by	• Propose a challenge that groups of students must overcome i.e. best value solution.

Topic 2.2 Informal sector activities

To pass the topic they need to know….	• Informal collection – how is it undertaken/ best practice and associated risks to human health and the environment
	• What makes it informal?
	• Dismantling and separation
	  ○ Density
	• Strategies – share machines, special agreements (eg with big companies), quality buyers, retail networks etc
	• Processing and dangers – emissions, effluents and residues
	  ○ Burning
	  ○ Acid leaching
	  ○ Hazardous waste dumping
	  ○ Stealing materials
	  ○ Melting solders acid release from batteries
	  ○ Open smelting

To put their knowledge to use they will need skills (and knowledge) in….	• Understand risks • Understand markets • Negotiation ability • Strategy to deal with suppliers and buyers
We will know they have learnt because we will assess them by	• Theoretical test – strategies / market • Practical identification - risks

Topic 2.3 Business plan development and entrepreneurship

To pass the topic they need to know….	• Evaluation of business opportunities
	• Identification of business objectives
	  ○ Resources needed – human, financial, equipment
	  ○ Market analysis
	  ○ Competitor analysis
	  ○ Customer identification and access
	  ○ Publicity / marketing
	  ○ Financial opportunities

To put their knowledge to use they will need skills (and knowledge) in….	• Utilise excel spreadsheets • Outline a business plan • *Assess opportunities*
We will know they have learnt because we will assess them by	• Develop a draft business plan

Topic 2.4 Plant layout

To pass the topic they need to know….	• To design a plan for a plant that processes particular WEEE material- component processes, flow, logistics and spacing
To put their knowledge to use they will need skills (and knowledge) in….	How to calculate area/ determine physical arrangement of units for the operation of the plant – for example • calculate the area to store materials to be processed, calculate space for working stations (design of spaces + access depends on materials to be processed) • calculate area of disassembled materials and of general requirements (for example if container has to be loaded according to particular requirements • .Access area where materials can be loaded onto truck (eg -= Hanter Metails needs 18 tons of material to fill a container truck) Design of Administrative area – development of necessity (size of company, product range etc.) Knowledge of safety measures which need to be taken into account
We will know they have learnt because we will assess them by	• To develop plan with planned layout for particular WEEEE treatment/ volume to be processed

Topic 2.5 Reuse and repair business planning

To pass the topic they need to know….	• WEEE management – business planning and entrepreneurship in the field of e-waste. • Capacity to analyse and elaborate business plan and viable company financing • *Identification of market opportunities including volumes, product types, markets etc* • Knowledge and on existing techniques and legal requirements – licences, certificates etc *Alternative funding opportunities eg social inclusion etc* • *Key principles that must be applied*
To put their knowledge to use they will need skills (and knowledge) in….	• Knowledge on laws and by laws • Innovation creativity and company know how • Knowledge on technologies and techniques • Basic financial interpretation
We will know they have learnt because we will assess them by	• Presentation on a simulated business model including analysis of viability of reuse and repair

2.5. Module 3 – Practical Dismantling

The practical dismantling module, provided within CPD courses will focus on the main WEEE categories according to the European WEEE-Directive. Each module can be selected separately, so that interested participants can get the knowledge in terms of their field of interest. The practical dismantling modules are offering the possibility to be rewarded with ECTS points as well. Since practical dismantling is an newly developed CPD educational product, more details on the contents and structure of the newly developed practical dismantling courses is available in the report D4.3.

3. Recycler Information Center (RIC)

The Recyclers Information Center (RIC) is a centralised web platform providing information regarding WEEE treatment, and has been developed as part of the CloseWEEE project funded by the Horizon 2020 research and innovation programme. The RIC content is available in more than 12 languages, among others in English, Russian, Chinese, Japanese, and Spanish.

The RIC platform aims to provide the basic information of manual disassembly for both the repair and reuse and recycling. In the case of disassembly, the focus is placed on the more efficient repair or harvesting of components. In the case of pre-separation, the focus is placed at higher quality of recycled fractions.

One of the major advantages of the platform is an alternate process during which both the content and form have been developed in consultation with manufacturers, recyclers and reuse centers, and other actors in order to ensure that it meets the needs of all stakeholders concerned. In order to ensure the quality level, all content uploaded to the platform is previously checked and approved by the administrators with required training.

3.1. Structure of the RIC platform

The RIC platform is organised into several subsections including general information, generic disassembly procedures, and product and fraction specific information (see Fig. 1).

The general information section contains information on health and safety while dismantling hazardous components, a short explanation of the EU WEEE directive, and a separate section on the categories of waste electronics determined by the WEEE directive and their harmonisation with the UNU Keyes. The description of the hazardous components focuses on the four devices groups, i.e. computer / laptop, mobile phones, printers, and cables / wires. This section describes constituting components of the already mentioned device groups and necessary precaution measures while dismantling hazardous components. On the other hand, the hazardous

components are addressed again as part of the subsection of fraction-specific information. However, in the latter case the focus is placed on the characteristics of these components.

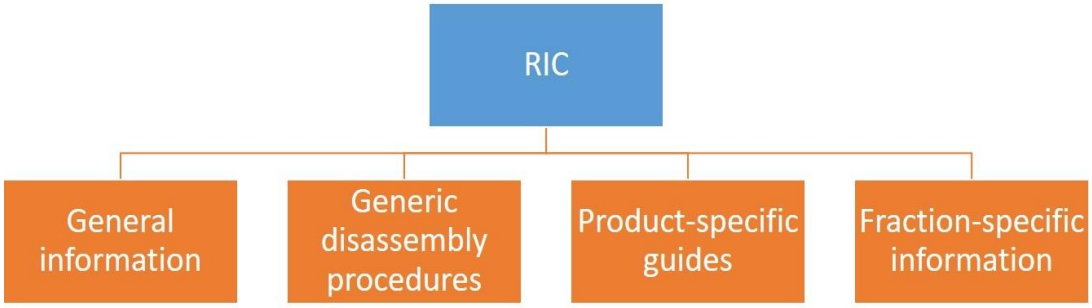


Fig. 1: Content organisation of the RIC platform

Section on the generic disassembly procedure focuses on the dismantling guidelines of larger device groups, such as computers, large household appliances, screens and monitors, small equipment, and other. In continuation, a RIC dismantling guide will be explained on the example of a PC.

The structure of the workshops resembles the one available on the RIC homepage and focuses on the following fractions: metals, printed circuit boards, plastics, hazardous materials, mixed materials, CRT glass, and critical raw materials (see **Fehler! Verweisquelle konnte nicht gefunden werden.**).

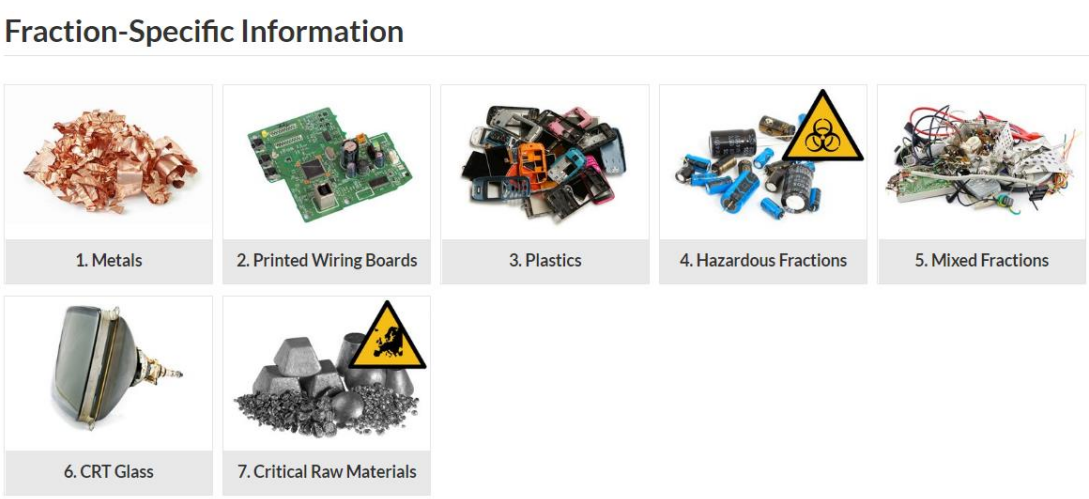


Fig. 2: Screenshot of the fractions resulting from manual dismantling (RIC homepage)

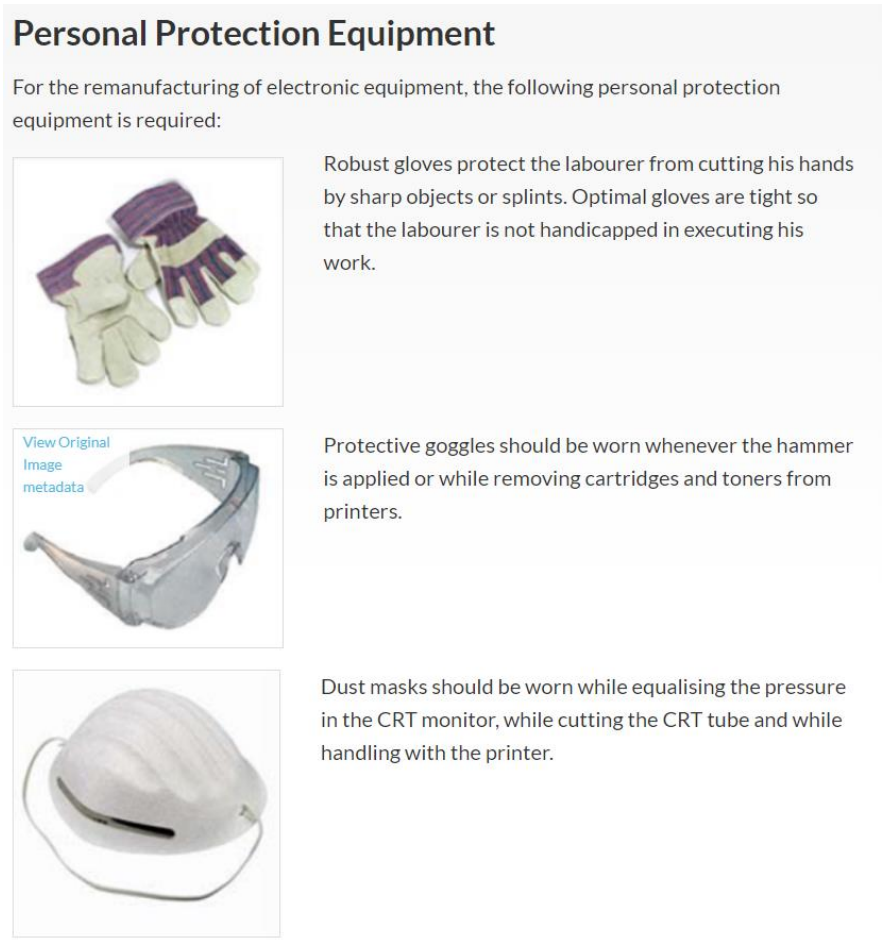


Fig. 3: Screenshot of the health and safety information on the RIC homepage

At the beginning of the dismantling guide for any particular device, the RIC platform provides some basic information about the difficulty of the dismantling process, number of described disassembly steps, and estimated dismantling time (see Fig. 4). The introductory information contains also the basic information about the device itself, basic health and safety information, and for the disassembly necessary toolkit. Furthermore, each individual item from the toolkit is linked to the additional information about the item and for which other dismantling devices it is needed.

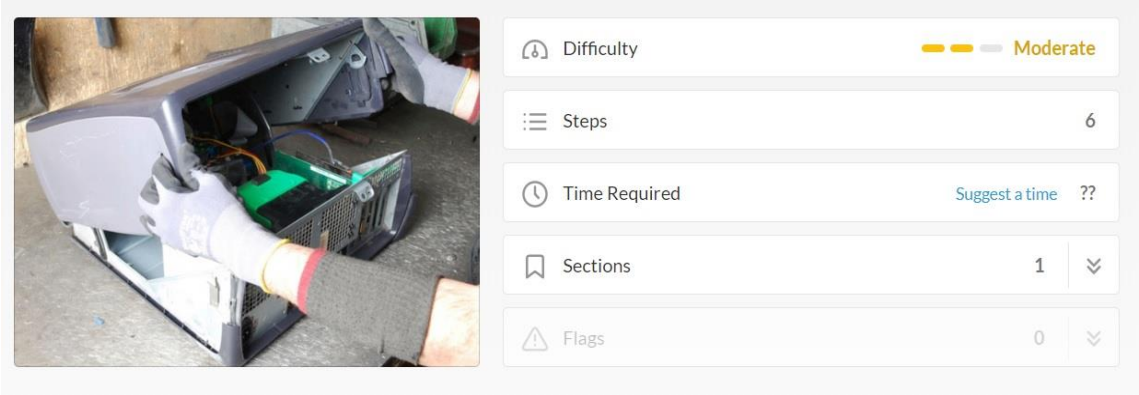


Fig. 4: An interface with the basic information about the dismantling procedure

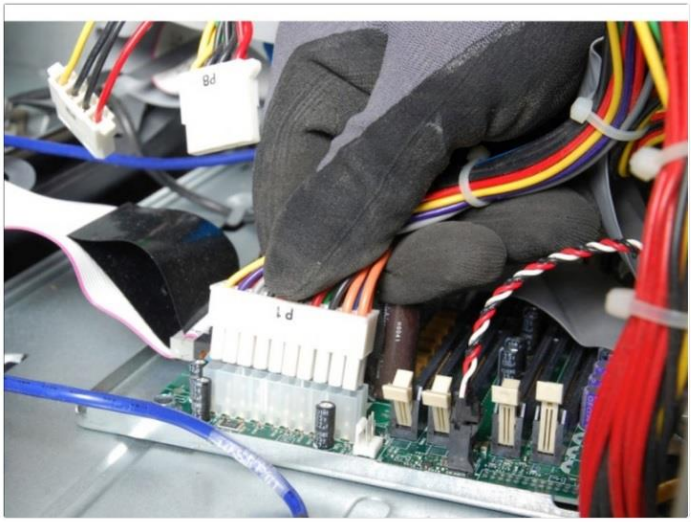
Following the introductory information are individual dismantling steps, which include basic guidelines for the dismantling and the resulting material fractions. The dismantling guide for the PC contain following steps:

Step 1

- Remove the CU casing to get access to the internal components by unscrewing all screws. Use an automatic screw driver where applicable to save time.
- Put the cover aside.

Fig. 5: Disassembly of the PC casing

Step 2



- Now remove the screws holding the internal components to be able to remove them all.
- Unplug all the cables and wires by pulling them straight out or releasing them by applying pressure to the clip in case they have a locking clip.

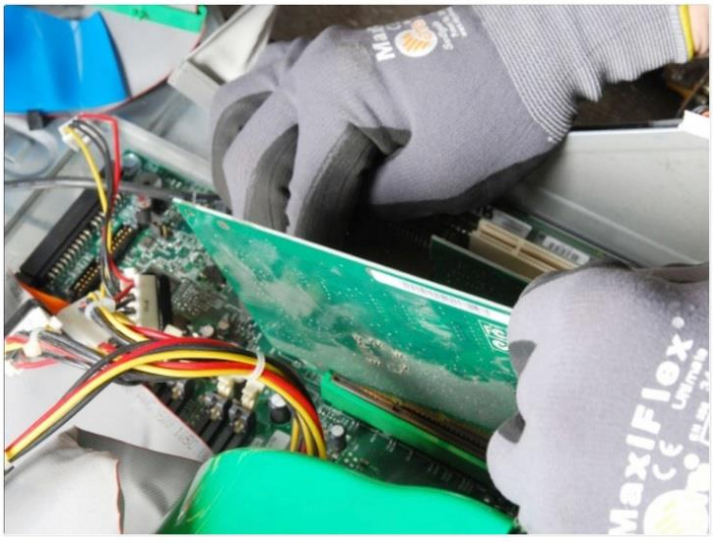
Fig. 6: Unplugging the ribbon cables

Step 3

- Once all wires and cables have been disconnected the drives (floppy drive, CD drive and hard disk drive, etc.) can be removed. Also remove the power supply.

Fig. 7: Removal of the Power Supply Unit

Step 4



- To remove the motherboard it is necessary to remove all other components first from the computer case. Along with the motherboard all other PWBs can be removed.

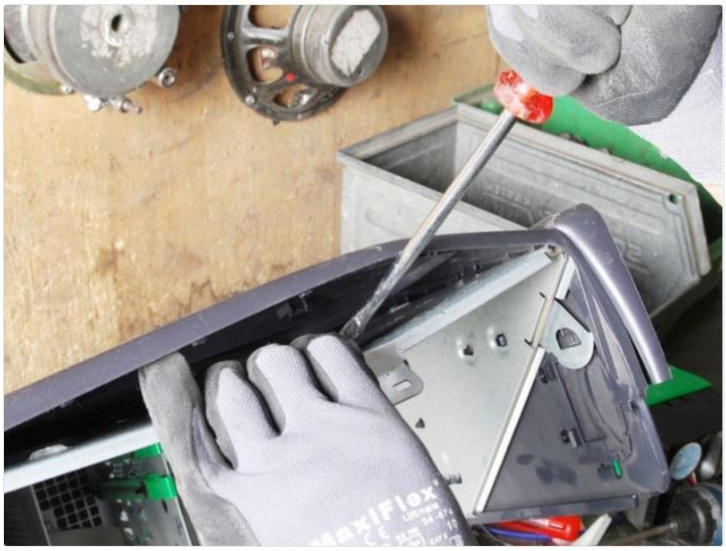
ⓘ The number of mounting screws attaching the motherboard to the case will vary from 3-10 depending upon design. Some will be held in place with plastic clips rather than screws. For removal of plastic clips, simply pry them off with a screwdriver.

- The motherboard contains some components that can be removed such as RAM, Cmos battery, NIC (network interface card) and the CPU (central processing unit).

⚠ Put any batteries in a separate box for adequate disposal!

Fig. 8: Removal of the extension cards

Step 5



- After removing the motherboard, the casing should be completely blank.

Fig. 9: Separation of the residual parts from the PC casing

Step 6

- Separate the remaining materials according to their type.
- Make sure the plastic parts are completely free of metal pieces.

Fig. 10: Overview of the resulting material frcations

3.2. Summary of the RIC platform

The RIC platform is a central platform regarding dismantling guides due to two crucial factors. First, the iterative nature of the platform enables the users from various parts of the world either to seek additional information or to upload the new content themselves. This enables the platform to increase and update the available database. Secondly, the platform provides a simple dismantling scheme consisting only of several dismantling steps per device and accompanying photos.

Furthermore, much of the content from the RIC platform is available in 12 different languages making it more approachable for the non-academic community or for the people, whose knowledge of English language poses a challenge.

On the other hand, the simplicity of the dismantling procedure carries also risk that certain aspects of the dismantling process have not been shown and that the users will have complication following the instructions. In addition, the visual aid is limited only to the phots and no video material has been made available so far.

In order to make the dismantling process more readily available to the continuous generation of CPD courses, it would be beneficial if the dismantling process is filmed and made available in a form of a short video.

4. YouTube

Beside being a popular platform for different entertainment content, the YouTube has established itself also as a platform for all sorts of “how to” questions. Thus, also subjects related to the manual disassembling and repair of used electronics have increasingly been introduced to the platform.

4.1. laWEEEda YouTube channel

In July 2017 the laWEEEda Project YouTube channel has been started and since than it contains 14 videos covering various issues from general environmental impacts of improper waste management up to specific WEEE related subjects, e.g. collection, material composition characterization, repair and reuse, pre-treatment, recycling and finally disposal of WEEE.

The videos are in average between 8 and 10 min. long and therefore correspond with the standard YouTube format. Depending on the specific subject, they vary in from between presentations, animated videos, interviews, or a combination of those (see Fig. 11).

Although, all of the currently available videos have been developed by the São Paulo State University from Brazil and therefore are in Portuguese, the videos have English subtitles so that their target audience goes beyond Portuguese speaking countries. However, at the moment the videos still have only couple of dozens of views and further action is necessary to increase the visibility of the content on the YouTube.

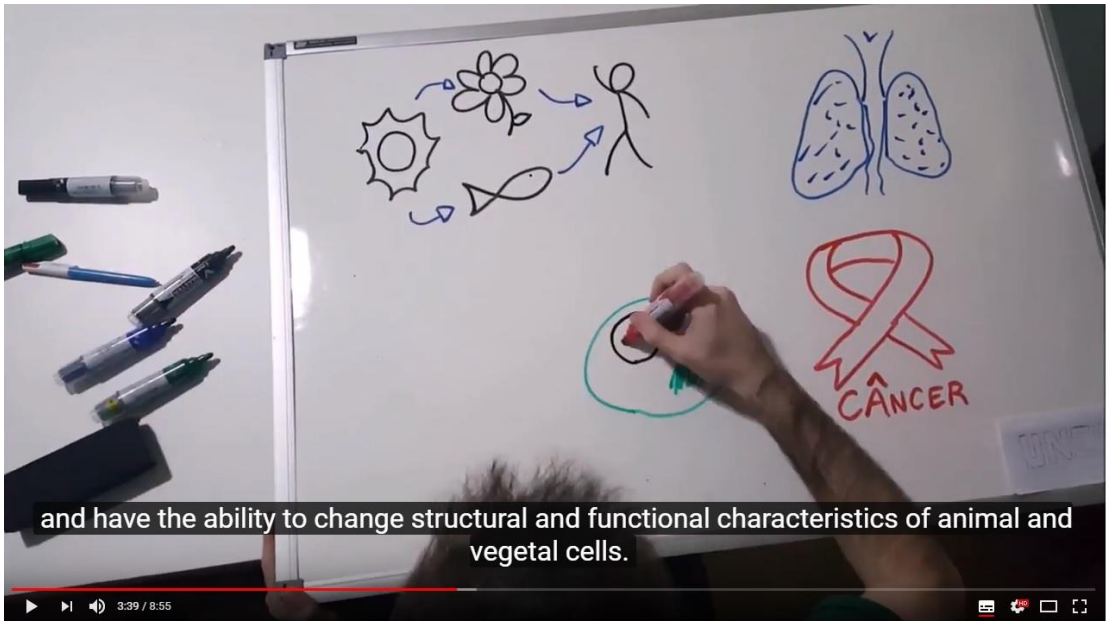


Fig. 11: An example of animated video on the laWEEEda YouTube channel

4.2. Other YouTube channels

Because of the sheer size and number of channels and videos available on the YouTube, the probability to find a dismantling guide for a particular model of a device is much higher than on any other platform. Although the vast majority of the content is in English language available, there is also significant number dismantling videos in Spanish, Portuguese and other languages. Finally, as a proof that the dismantling videos on the YouTube have found its target audience is the number of views for these videos, which range between several hundred up to several hundred thousand (see Fig. 12).

However, the YouTube does not have any review process for the content of the videos, as it was never intended to be the source of scientific material, the health and safety aspects as well as the validity, integrity, and accuracy is doubtful for much of the content. Furthermore, because of the same reason, the video quality of the videos and the quantity of available information varies significantly.

Conclusively, the dismantling videos on the YouTube can only in rare cases match the quality of content those available on the specialised platforms. However, due to their number and number of views should not be completely ignored and they can offer a first glimpce into the subject or to provide information on specific model of an electronic device.

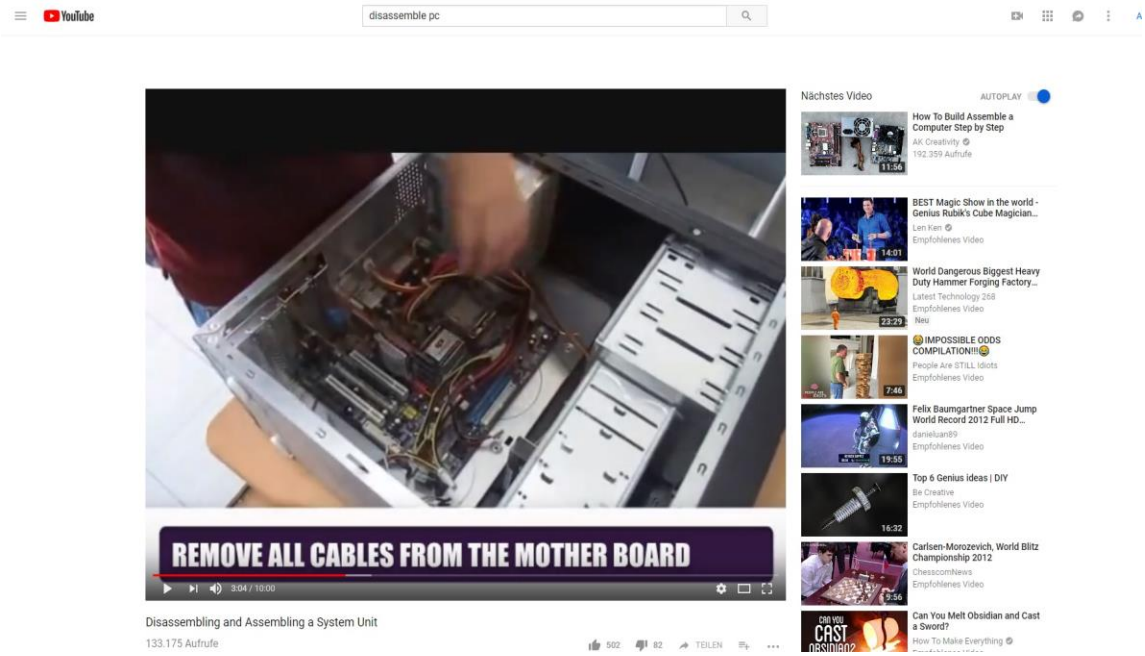


Fig. 12: Example of a dismantling guide from YouTube