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LaWEEEda

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

D3.1 List of academic educational products to be adapted and developed

D4.1 List of CPD educational products to be adapted and developed

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PART I - D3.1 List of academic educational products to be adapted and developed

In the following Part I of this deliverable, the list of academic educational products that are going to be developed within the project are described.

Introduction

Within the project "Latin America-European network on Waste Electrical and Electronic Equipment, research, development and analysis" (LaWEEEda) capacities of universities and training organizations in Brazil and Nicaragua for delivering modern high quality academic education and continuing professional development (CPD) training courses in the area of WEEE management and related entrepreneurial skills will be established.

The aim of work package 3 is to improve academic education in the field of e-waste by:

- **Increasing the capacities of Universities** to provide better education in the field of e-waste management;
- Linking Universities with enterprises and considering **demand-driven approaches**;
- **Developing new** and to **adjust existing academic educational products** (technical contents, emission control and occupational health and safety);
- Developing innovative educational products for Universities including workshop series for joint development of educational products;
- Increasing capacities of academic staff with train-the-teacher workshops;
- Preparation of approval of new and adapted educational products into existing curricula;
- Developing a scheme/model for different educational paths;
- Proofing the high quality of the developed modules and courses by internal quality assurance and pilot phases.

Therefore, it is highly important to select relevant modules, courses and educational products for academic education and CPD (see Part II of this deliverable) which can be implemented at the partner universities in Brazil, i.e. Rio de Janeiro (UFRJ), Sao Paulo (UNESP) and Léon (UCAN and ULSA both in Nicaragua).

Methodology for 3.1 and 4.1

Deliverables 1.1, 1.2 and 1.3 in WP 1 focussed on creating the information basis. In WP 1, a holistic overview of existing capacities was developed.

Deliverable 1.1 compiled a holistic inventory of existing teaching and training capacities and the related gaps and needs, for the partner countries Brazil and Nicaragua country profiles were developed. The country profiles were developed within an MS Excel file for both countries (Brazil and Nicaragua), but also at city level (Sao Paulo, Rio de Janeiro, Léon and Managua). The goal was to collect data on geography and demography, politics & economics, universities and teaching courses, waste management in general and WEEE management.

Within the Kick-Off meeting which took place from April 03rd until April 07th 2017 in Rio de Janeiro, the first preparatory workshop was realized. After several discussions beforehand during online meetings, the consortium of LaWEEEda provided a World Café with stakeholders from Brazil and Nicaragua who are related to WEEE management within their countries aiming at linking Universities with enterprises and considering demand-driven approaches (results see in Deliverable 1.2). Based on this, to extend the information basis within WP1, preparatory activities regarding specific national, regional, social, gender and ethical aspects have been analyzed considering aspects in Brazil and Nicaragua (see Deliverable 1.3.).

In a second preparatory workshop in Léon (July 3rd to July 7th 2017) within the consortium it was discussed, how the educational products being developed should look like in terms of topics covered and duration. It was of paramount importance to include the business partners opinion in the discussion. Prior to this second preparatory workshop, an Excel file was developed jointly outlining major contents. These contents were discussed virtual in online partner meetings also. The above described methodology was used both for the contents related to WP 3 and WP 4.

Learning outcomes for academic courses

In the following, the learning outcomes for the three modules and the corresponding lectures are displayed.

Module 1 – Environmental impacts with special emphasis on waste topics

	After passing this course participants are able to understand …
Lecture 1.1 Environmental impacts	… general environmental impacts and other impacts due to improper waste management, ranging from global to regional and local effects and covering GHG emissions and the related climate relevance of improper waste management, impacts on soils and water bodies, odour emissions, as well as fertilising aspects of the biogenous share in the municipal solid waste stream. Further the participants are able to work with the Lice Cycle perspective, are familiar with other assessment approaches and the concept of Integrated Sustainable Waste Management (ISWM).
Lecture 1.2 Household waste generation	… the theory of waste generation and the related factors of influence. Participants are aware of the definitions for different waste streams, find access to information on quantities of waste generated around the world and are able to assess the quality of data and information on waste as a pre-requisite for any planning activities.
Lecture 1.3 and 1.4 Waste collection	… the function and design of municipal waste collection schemes. They are able to develop a collection scheme using different container types, collection systems and collection vehicles. Beside formal collection, the participants are aware of the informal recycling sector (IRS) and its potential contributions to waste management. They are able to develop a scheme for the

	separate collection of recyclables or apply other possibilities to recover resources from the waste stream.
Lecture 1.5 Processing of recyclables	… the relevant processing technologies for recyclables and to assess the possible advantages and disadvantages of certain technological solutions.
Lecture 1.6 Hazardous waste	… sources and types of hazardous waste, know the relevant approaches for the collection, storage and treatment and are able to develop a treatment plan for hazardous waste.
Lecture 1.7 Waste treatment technologies	… the relevant technologies for the treatment (disposal and composting) of municipal waste streams. Participants then are in a position to develop a treatment concept using mechanical - biological treatment, composting, anaerobic digestion (biogas), waste incineration technology and landfill technology.
Lecture 1.8 financial aspects	… cost types and cost drivers in a waste management system and know the options to recover costs and generate revenues. Furthermore they are able to develop tariff schemes and to work with the concept of Extended Producer Responsibility.
Lecture 1.9 excursion	… practical implementation of technologies and related challenges.

Module 2 – WEEE management – theoretical knowledge

	After passing this course participants are able to understand …
Lecture 2.1 Policy and legislation for e-waste	… the background on legal regulations for e-waste. They know the major policies and programmes as well as the different approaches for the implementation of national e-waste programmes. Examples are Brazil with its sectorial agreements, the European WEEE directive and related

	national implementations, other national approaches like in Colombia, Peru, Japan or Canada.
Lecture 2.2 Sources and generation of e-waste	… the different types of e-waste generators and the WEEE categories incl. typical items represented in these categories. They are familiar with mechanisms for e-waste generation in different countries and related factors of influence on the generation.
Lecture 2.3 Reuse and repair	… the business models of reuse and repair, as well as their organisational setup, techniques and legal aspects. From examples and case studies from different countries participants know how to develop reuse and repair concepts.
Lecture 2.4 Collection and take back systems	… the options for e-waste collection and the take-back of end-of life products by retailers and producers. Beside formal collection systems participants are also familiar with informal collection systems for e-waste.
Lecture 2.5 Material composition of different WEEE categories	… the material composition of different WEEE categories. They are familiar with specific components, the materials used, valuable material and hazardous contents and are able to use this information for the development of the subsequent dismantling, recycling, treatment and disposal processes and options.
Lecture 2.6 De-pollution and dismantling	… de-pollution and dismantling of e-waste. They know typical procedures and occupational health and safety issues related to these processes. With this the participants have the theoretical knowledge for practical dismantling.
Lecture 2.7 Mechanical processing	… the technologies for the processing of e-waste after dismantling such as fragmentation and separation processes.
Lecture 2.8 Specific treatment processes	… specific treatment processes for cathode ray tubes (CRT), flat panel displays, cables, lamps, printed circuit board and brominated flame retardant (BFR) plastics and are able to apply such treatment processes.

Lecture 2.9 Final treatment - recycling	… the processes which are applied for the final processing (recycling) of WEEE components and their use as secondary raw materials, e.g. for ferrous metals, non-ferrous metals, aluminium and plastics.
Lecture 2.10 Final treatment - disposal	… the technologies and processes for the disposal of hazardous wastes from e-waste treatment. They are familiar with technologies for proper disposal and adverse impacts of improper disposal.

Module 3 – WEEE management – practical knowledge

	After passing this course participants are able to understand …
Lecture 3.1 Financial aspects – Costs and markets	… cost types, cost drivers and the cost relevance of processes. Beside knowledge on the costs related to different processes the participants are familiar with market options for valuable materials resulting from WEEE dismantling and recycling. With this, they are able to assess the financial sustainability of e-waste management solutions.
Lecture 3.2 Informal recycling sector activities	… in the context of Informal Recycling Sector (IRS) activities typical processes for dismantling, recycling and treatment; emissions and impacts (human health, environmental impacts) due to informal activities as well as potential strategies to integrate informal recycling actors in e-waste.
Lecture 3.3 Business plan development and entrepreneurship	… how to develop a business plan for a dismantling facility. The participants develop business and start-up ideas (“start-up and innovation garage”) in the field of e-waste. The participants get familiar with the CEFE (Competency-based Economies through Formation of Enterprise) approach and the StEP – Business Calculation Tool.

Lecture 3.4 Plant layout	… technical details regarding the plant layout and equipment needed for a dismantling facility.
Lecture 3.5 Laboratory and field layout	… typical laboratory and field tests which are used for material identification, including sample preparation, lab analyses, composition analyses of different WEEE categories, pollutants and quality of secondary materials.
Lecture 3.6 Efficient WEEE dismantling	… efficient WEEE dismantling using the equipped training stations in the LaWEEEda centres.

Learning outcomes for CPD courses

During the second preparatory workshop in Vienna in December 2017, a session was carried out dealing with defining learning outcomes for CPD courses. The goal was to ask all partners (including business partners) in groups to elaborate on objectives and specific learning outcomes for each specific CPD course.

The **compiled objectives** for CPD courses was described by the partners as following:

By the end of the course the trainee will be able to…..

- Dismantle various EEE devices taking into account health and safety measures
- Classify materials
- Have a thorough understanding of waste management in their country
- Identify the challenges of e-waste management – in general and country specific
- Know the types, characteristics, classification of e-waste and associated environmental and occupational risks
- Adequately lead / manage an e-waste business and apply recommended techniques
- Correctly deal with e-waste
- Identify the environmental dangers and state the solutions
- Correctly dismantle WEEE devices
- Safely and confidently dismantle
- Use PPE appropriately
- Identify the importance of a healthy environmental
- Dismantle e-waste safely and separate according to categories (knowing about values and potential dangers)

- Know about e-waste and be able to work in different stages of its management
- Be an ew-aste management administrator
- Identify the necessity to dismantle e-waste and incorporate it into a circular economy
- Identify all sub products / fractions
- Use tools
- Dismantle thanks to prior experience
- Understand the global e-waste context
- Know about dangerous residues
- Ability to process e-waste legally, efficiently and in an environmentally friendly way
- Understand the importance of correct e-waste management in the following subjects – economy, social and environment

The participants also worked on defining **specific learning outcomes**. In the following pages these outcomes are displayed.

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 – o analytical ability to describe and analyse market chain o analyse statistical data o collect data and produce charts o make basic calculations • Theorectical tests o True false tests o Multiple choice o Fill in tests o 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: o Choosing an appropriate business plan o Process and classify two materials o 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 o Analyse current situation

	o 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?
	  o What capacity, efficiency?
	  o Operational processes?
	  o What materials?
	  o Risks, health and safety, PPE etc
	  o 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
	  o Understand risks / technologies
	  o Designed process flow and layout (reproduce and model)
	  o Undertake mass balance
	  o Define appropriate processes for each WEEE type
	• Practice
	  o 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 o In company or external? o Processes? o Costs? o Special restrictions / controls (storage, containers etc)? o 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 o Identification of ▪ laws and standards ▪ types of materials ▪ technologies • Case study o Planning / disposal for a specified o Gaps in standards / laws

Level 2 modules

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
	  o Density
	• Strategies – share machines, special agreements (eg with big companies), quality buyers, retail networks etc
	• Processing and dangers – emissions, effluents and residues
	  o Burning
	  o Acid leaching
	  o Hazardous waste dumping
	  o Stealing materials
	  o Melting solders acid release from batteries
	  o 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 o Resources needed – human, financial, equipment o Market analysis o Competitor analysis o Customer identification and access o Publicity / marketing o 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

The learning outcomes for the practical dismantling courses (Module 3: lectures 3.1 to 3.5)) are related to the issue, that successfully completing participants should be in a future position to:

- Understand the sequence of practical dismantling and depolluting of a specific WEEE;
- Get to know the specific tools that are needed for dismantling and depolluting;
- Know the valuable parts and the hazardous parts / components of a specific WEEE;
- Understand the proper storage of WEEE and the components after dismantling / depollution
- Are aware of all necessary occupational health and safety measures for all depolluting and dismantling sequences of a specific WEEE.

Participants will be assessed by conducting a practical dismantling of a specific WEEE combined with an oral examination.

Workload of the modules, courses and educational products for academic education and CPD

During the partner meeting in Léon, it was finally decided,

- that the academic courses are divided into three modules;
- to implement modules with a workload of **two teaching hours (th) per week in each of the 12 weeks of a semester;**
- which leads to a **total work load** of **24 th for each semester and module**.

The following Table 1 illustrates the understanding of a module`s workload within the LaWEEEda project in terms of academic courses.

Table 1 - Workload of a module regarding academic courses

1 teaching hour	→	45 min
1 semester	→	12 weeks
1 module	→	2 teaching hours/week
Total work load per module	→	**24 hours/semester**

For the CPD courses mainly aiming at practitioners (business operators, e.g. private companies / cooperatives, authorities, NGOs etc.), it was reported by business partners that it is reasonable to provide educational products more “blocked”, i.e. concentrated, in order to allow practitioners not to lose too much time for participation in courses. With respect to this, it was agreed, that one teaching day is reflected in 7 hours (plus 1 hour break) and that one course module should last 2 days maximum. This means, the total workload per module is 14 hours of net teaching (see Table 2).

Table 2 - Workload of module I and II regarding CPD courses

1 teaching hour	→	60 min
1 working day	→	7 teaching hours
1 module	→	2 days
Total work load per module	→	**14 hours/module**

Beside theoretical knowledge for practitioners, it is also intended to provide practical dismantling courses (modules). These courses aim at using the established LaWEEEda training centers to provide practical courses for dismantling of specific WEEE categories focusing on proper dismantling, identifying hazardous components, valuables, occupational health and safety issues related to dismantling, proper storage etc.

Regarding the CPD practical dismantling modules a workload of 7 hours within one day is foreseen. The workload for one dismantling course is divided into three hours of theoretical knowledge transfer and four hours of practical knowledge transfer (see Table 4).

Table 3 - Workload of CPD practical dismantling courses

1 teaching hour	→	60 min
Theoretical knowledge transfer	→	3 teaching hours
Practical knowledge transfer	→	4 teaching hours
1 module	→	1 day
Total work load/module	→	**7 hours/module**

Selection of relevant modules, courses and educational products for academic education

This chapter will provide the results concerning the list of modules, courses and educational products for academic education.

Based on WP 1 (Tasks 1.1 and 1.4) the selected modules, courses and educational products were screened regarding their target groups, didactical methods used, learning outcomes and contents. The existing contents of these educational products are described in the following and the links to waste and resource management (special focus e-waste and the related entrepreneurial skills) are displayed in detail.

The main educational products for academic education will be divided into three modules:

- **Module 1: Environmental impacts with special emphasis on waste topics**
- **Module 2: WEEE management | theoretical knowledge transfer**
- **Module 3: WEEE management | practical knowledge transfer**

Within WP 1 it was detected, that in Nicaragua also basic waste management topics are missing in University education. Therefore it was decided, to include some general lectures on waste management, as this is necessary to embed the e-waste topics specifically. E-waste education cannot be seen as stand-alone, it hast to be seen and taught in the context of general waste management education (Module 1). This is focused on educating in particular students in Nicaragua regarding environmental impacts of improper waste management in general to create a knowledge base to build on in further and specified WEEE management teaching units. In addition, this Module 1 serves a knowledge base in waste management, whereas Module 2 and 3 build upon this Module 1. Nevertheless, the contents being developed can also be used in Brazil.

Module 1 – Environmental impacts with special emphasis on waste topics

Following the outcomes of D1.1, management and teaching capacities related to WEEE management are much more developed in Brazil than in Nicaragua. Therefore, the consortium decided to implement Module 1, which covers also general topics about environmental aspects with a special emphasis on waste issues. As there are no capacities existing in the field of environmental impacts or waste topics in general, Module 1 is addressing in particular the partner universities in Nicaragua, as they have to provide basic knowledge to build up on to their students, before teaching detailed WEEE topics. Due to the transmission of basic knowledge about waste topics, the understanding of main issues regarding WEEE management will be much more efficient.

Basically, Module 1 starts with describing in general environmental (and other) impacts due to improper waste management (Lecture 1.1). The impacts range from global to regional and local scales and cover GHG emissions and the related climate relevance of improper waste management, impacts on soils and water bodies, odour emissions and other impacts on (primary) resources recovery and related emissions (primary raw materials, fertilising aspects of the biogenous share in the municipal solid waste stream). It is important to highlight the environmental impacts also from a Life Cycle perspective in order to consider also less obvious impacts. It might be also reasonable to include (at a later stage) issues related to assessing waste management systems (different methods, scenario-building, sustainability assessment, LCA etc.) and the concept of Integrated Sustainable Waste Management (ISWM) in monitoring existing or planning new waste management systems.

In addition, Module 1 (lecture 1.2) shall provide information on waste generation and the related factors of influence (consumption, basket of goods, trends, demographic issues related to waste generation etc.). In this lecture also contents related to different waste streams (definitions, quantities around the world) shall be discussed. It is important to explain also the importance of waste data in good quality as pre-requisite for any planning activities in waste management.

Lectures 1.3 and 1.4 aim at collection in waste management (focus on municipal solid waste (MSW)). Different options of waste collection issues are described, e.g. container types, collection systems, collection vehicles etc. Advantages and disadvantages are shown and also the informal recycling sector (IRS) and its potential contributions to

waste management are shown. A special focus is put on the separate collection of recyclables and other possibilities to recover potential resources out of the waste stream.

Lecture 1.5 is going to deal with processing technologies of recyclables giving an overview on technologies and possible advantages and disadvantages of certain technological solutions.

Lecture 1.6 is specialised on hazardous waste, displaying different sources and types of hazardous waste, its collection, storage and proper treatment / disposal.

Lecture 1.7 is focussing on waste treatment technologies. This includes mechanical-biological treatment plants, composting / biogas plants, waste incineration and landfills.

Lecture 1.8 is covering important financial aspects in waste management. The following questions shall be answered in this lecture: What are important cost types and drivers in waste management? How can costs be recovered and what type of revenues can be generated in waste management? What types of tariffs exist and how can tariffs be collected? What are extended producer responsibility schemes?

Lecture 1.9 shall deal with specialized excursions to different parts in waste management systems in order to allow students to combine theoretical knowledge with real life waste management applications in practice.

Table 4 outlines the contents of Module 1. The right column outlines a first draft of estimated teaching hours per semester for each lecture.

Table 4 - Content of Module 1 - Environmental impacts with special emphasis on waste topics

Lecture number	Chapter	Main Content	Workload in teaching hours per semester
1.1	Environmental impacts	General information about environmental impacts (2 th); focus on impacts of improper waste management (2 th)	4
1.2	Household waste generation	Consumption and waste, factors of influence, waste streams and quantities	2
1.3	Collection Part 1: Waste collection	Containers and bags, collection types and procedures, equipment, routing; informal collection	2
1.4	Collection Part 2: Separate collection	Source separation to recover recyclables / hazardous waste; sorting of mixed waste	2
1.5	Processing of recyclables	Processing of waste paper, glass, metal, plastics (Waste Resources Management)	2
1.6	Hazardous waste	Types of hazardous waste (organic, inorganic), storage, treatment	2
1.7	Waste treatment technologies	Relevant technologies within a proper Waste Treatment	2
1.8	Financial aspects	Costs and tariffs (Pay as You Throw concepts or tariff collected per m^2 residential area etc., revenues and markets in waste management); Extended producer responsibilities and other incentive systems	2
1.9	Excursion	e.g. dumpsite, landfill, dismantling plant, cooperative: write down learning outcomes of such an excursion	6
		Total:	**24**

The content developed in module 1 is based on good practices provided by the European partners from Austria (BOKU), Germany (TUHH) and Great Britain (TUON). Within additional six hours of workload site visits will be carried out. Table 5 provides information on what material is existing to what extent and quality and which partner is in charge for developing the contents. The partner in charge is responsible for collecting information within the consortium for the relevant lecture and compiles this to a course (also related to reasonable teaching tools). This partner is also in charge for the respective train-the-trainer and train-the teacher-workshops in WP 3 and WP 4.

The contents of Module 1 will not be provided as CPD course.

Table 5 - Existing material and partner in charge (Module 1)

Lecture number	Lecture title	BOKU	TUHH	TUON	UNESP
		Already existing material			
1.1	Environmental impacts			in charge	
1.2	Household waste generation		in charge		
1.3	Collection P1: Waste collection			in charge	
1.4	Collection P2: Separate collection	in charge			
1.5	Processing of recyclables		in charge		
1.6	Hazardous waste	in charge			
1.7	Waste treatment technologies		in charge		
1.8	Financial aspects			in charge	
1.9	Excursion		in charge		

Legend:

no material
some material
great material

Module 2 – WEEE management | theoretical knowledge transfer

Within Module 2 the main theoretical knowledge regarding proper WEEE management will be communicated. According to was set out already in the proposal, this module aims to provide information regarding the following topics:

Lecture 2.1 aims at providing a sound background information on the legal framework in e-waste management. An overview on the major policies and programmes is given related to the legal framework and different approaches for the implementation of

national e-waste programmes (Brazilian PRNS[1] and sectorial agreements, European WEEE-directive and national implementations, other national approaches like in Colombia, Peru, Japan or Canada). Also information is provided on how to fit e-waste management into the general waste legislation hierarchy or how to run a national e-waste take-back-system.

Similar to Module 1, in Module 2 also a lecture deals with the sources and generation of e-waste. This lecture 2.2 provides insights related to types of e-waste generators, WEEE categories incl. typical items represented in these categories and general aspects related to e-waste generation worldwide and factors of influence on the generation.

Reflecting the waste management hierarchy as set out in European waste legislation, lecture 2.3 displays information on reuse business models and repair, such as their organisational setup, techniques and legal aspects related to this (waste vs. product). Examples and case studies from different countries are given.

Lecture 2.4 focusses on e-waste collection and take-back systems. Different possibilities of formal collection and take-back systems are presented (including take back systems by retailers, by producers etc.). Beside this formal collection systems also the role of informal collection systems are discussed.

Lecture 2.5 is basis for all the other lectures in module 2 (2.6 to 2.10): here the material composition of different WEEE categories are discussed. It is important to obtain knowledge on specific components, materials used, valuable contents and hazardous material used for the subsequent dismantling, recycling, treatment and disposal processes and options.

Lecture 2.6 is going more into detail in the de-pollution and dismantling of e-waste. Typical procedures are presented by WEEE categories including occupational health and safety issues related to these processes. This lecture 2.6 is providing the theoretical knowledge for practical dismantling (link to the practical dismantling courses in the CPD section).

Lectures 2.7 and 2.8 are technology-specific lectures. In lecture 2.7 technologies (process engineering) are introduced, such as fragmentation and separation. In lecture 2.8 specific treatment processes for cathode ray tubes (CRT), flat panel displays, cables,

[1] Packaging Recovery Note - certificates of evidence that prove a tonne of packaging waste has been recovered and reprocessed or exported.

lamps, printed circuit board treatment and brominated flame retardant (BFR) plastics are outlined.

Lecture 2.9 puts a focus on recycling of different materials. In this lecture the core processes are displayed, linking WEEE components and their use as secondary raw materials, e.g. for ferrous metals, non-ferrous metals, aluminium, plastics etc.

Lecture 2.10 aims at final disposal of hazardous wastes. Technologies for proper disposal are shown and also impacts of improper disposal.

Generally spoken, Module 2 (see Table 6) is dealing with technical contents such as adequate strategies for the collection of e-waste, manual depollution and dismantling, technics for further treatment of specific devices and fractions (further treatment of CRT-tubes and separation of CRT-glass, depollution of Hg-containing lamps and fractions, separation) and answering questions such as how to transport and store e-waste and output fractions. Also information is given on conventional and advanced technologies for the treatment of e-waste and material recovery technologies. Analytic procedures for material identification are part of Module 3.

Table 6 - Content of Module 2 – WEEE management | theoretical knowledge transfer

Lecture number	Chapter	Main Content	Workload in teaching hours per semester
2.1	Policy and legislation for e-waste	Key principles in Europe, Brazil and Nicaragua	2
2.2	Sources and generation of e-waste	WEEE categories incl. typical items, types of e-waste generators	2
2.3	Reuse and repair	Reuse business models, repair - organisational setup, techniques, legal aspects (waste vs. product) - (http://www.frn.org.uk/publications.html); warranty and liability issues of reusable electronic products	2
2.4	Collection and take back systems	Formal and informal collection systems, retail, take-back by producers; best practice in Europe, Latin America, Asia	4
2.5	Material composition of different WEEE categories	Components, materials, valuable contents, hazardous material	2
2.6	De-pollution and dismantling	Typical procedures by WEEE categories incl. occupational health and safety	4
2.7	Mechanical processing	Fragmentation, separation, plant design	2
2.8	Specific treatment processes	Cathode ray tubes, flat panel displays, cables, lamps, printed circuit board treatment, BFR plastics	2
2.9	Final treatment - recycling	Ferrous metals, non-ferrous metals, aluminium, plastics	2
2.10	Final treatment - disposal	Hazardous wastes, waste for disposal: Technologies, impacts etc., storage	2
		Total:	**24**

The contents of Module 2 will be provided also as CPD course as this is important for entrepreneurs to have access to the theoretical know-how regarding a proper WEEE collection, recycling, treatment and disposal.

Table 7 - Existing material and partner in charge (Module 2)

Lecture number	Lecture title	BOKU	TUHH	TUON	UNESP
		already existing material			
2.1	Policy and legislation for e-waste			in charge	
2.2	Sources and generation of e-waste		in charge		
2.3	Reuse and repair	in charge			
2.4	Collection and take-back systems	in charge			
2.5	Material composition of different WEEE categories		in charge		
2.6	De-pollution and dismantling			in charge	
2.7	Mechanical processing		in charge		
2.8	Specific treatment processes	in charge			
2.9	Final treatment - recycling		in charge		
2.10	Final treatment - disposal			in charge	

Module 3 – WEEE management – practical knowledge transfer

Based on the theoretical knowledge related to e-waste distributed in Module 2, Module 3 will transfer this knowledge more into practical units. In this module, a basic input will be given to the participants about how to build up new facilities and how to support start-ups and entrepreneurship in the field of WEEE management.

Lecture 3.1 starts with an introduction on the financial aspects in e-waste management. It is important to understand what are the most cost-relevant processes and what cost types and drivers exist. It is intended to provide knowledge on the costs related to different processes and also show market options for valuables generated within WEEE dismantling and recycling. Beside the costs also the revenue side of e-waste is highlighted in order to provide financial sustainability of e-waste management solutions. This lecture provides a strong cross-link to lectures 2.5 and 3.3.

Lecture 3.2 focusses on a special issue related to e-waste in low-income countries and countries of transition. Beside collection of e-waste (partly mentioned already in lecture 2.4), in this lecture deepened information is provided on other activities in the system, that might be carried out informally, such as:

- Typical dismantling / recycling and treatment processes;
- Emissions and impacts (human health, environmental problems caused) due to informal activities
- Potential strategies to integrate informal recycling actors in e-waste (formalisation, professionalization, legalisation, integration, cooperatives etc.).

Lecture 3.3 is dealing with a core topic of the LaWEEEda project. On the one hand, this lecture aims at providing information on how to develop a business plan for a dismantling facility. On the other hand, it is intended to support business ideas and entrepreneurship in the field of e-waste. It is planned to provide a multi- and interdisciplinary lecture, where students from other disciplines join students from the LaWEEEda field. The lecture shall provide business and start-up ideas ("start-up and innovation garage") in the field of e-waste. Business ideas can be collected and assessed in this lecture, a special focus shall be put on socio-economic enterprises.
This lecture is also linked to WP 5 (Task 5.1.3 – Trainings related to entrepreneurial skills), the following concepts and tools can be used and applied:

- CEFE – Competency-based Economies through Formation of Enterprise[2]
- StEP – Business Calculation Tool: this open source tool was developed between 2012 and 2015 within the StEP-Solving the E-waste Problem network with strong participation of the associated partner DRZ. It aims to support entrepreneurs in planning and designing their e-waste recycling businesses. Depending on the expected input quantities and composition the tool calculates

[2] Is a comprehensive set of training instruments using an action-oriented approach and experiential learning methods to develop and enhance the business management and personal competencies of a wide range of target groups, mostly in the context of income and employment generation and economic development. It represents an accumulation of instruments for entrepreneurship training combined with an active and dynamic approach and methods of empirical learning in order to develop and improve managerial and individual skills. Rather than solely transmitting information, CEFE trainings aim at creating competences including knowledge, attitudes, skills and habits. The trainings enhance the participants' ability for self-organised decisions and action taking in complex and continuously changing systems. The different training modules are based on the "Experiential Learning Cycle" and comprise structured discussions, deductive trainings, case studies, role-plays, simulations, field studies and fieldwork (http://cefe.net/about/)

the estimated quantities of different output fractions. Depending on downstream-options (distances and prices) and levels of cost drivers like salaries, infrastructure costs, fuel and others that have be chosen staff and space requirements are calculated as well as expected revenues and costs divided in different groups (transport costs, infrastructure costs etc.)

Lecture 3.4 deals with more technical details regarding the plant layout and equipment needed for a dismantling facility.

Lecture 3.5 is focussing on laboratory and field tests, which are of specific importance in higher education related to e-waste. In this lecture, theoretical and practical knowledge is delivered regarding material identification, specific sample preparation, lab analyses, composition analyses of different WEEE categories, pollutants and quality of secondary materials etc.

Lecture 3.6 provides practical units for efficient WEEE dismantling using the equipped training stations in the LaWEEEda centres.

Table 8 provides an overview on Module 3and the related workload.

Table 8 - Content of Module 3 – WEEE management – practical knowledge transfer

Lecture number	Chapter	Main Content	Workload in teaching hours per semester
3.1	Financial aspects - Costs and markets	Costs by processes, markets by materials, revenues	4
3.2	Informal recycling sector activities	Collection, typical treatment processes, emissions and impacts, integration strategies	2
3.3	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	6
3.4	Plant layout	Examples of how to design various units in WEEE treatment plants	2
3.5	Laboratory and field tests	Material identification, laboratory analyses, composition analyses, pollutants, quality of secondary materials etc. mobile phones and notebooks	4
3.6	Efficient WEEE dismantling	Practical units of dismantling various WEEE products at training centers	6
		Total:	**24**

The following Table shows the partner in charge and the state of already existing material that can be used for teaching.

Table 9 - Existing material and partner in charge (Module 3)

Lecture number	Lecture title	BOKU	TUHH	TUON	UNESP
		already existing material			
3.1	Financial aspects - Costs and markets	in charge			
3.2	Informal recycling sector activities	in charge			
3.3	Business plan development and entrepreneurship				in charge
3.4	Plant layout				
3.5	Laboratory and field tests				
3.6	Efficient WEEE dismantling				

PART II – D4.1 List of CPD educational products to be adapted and developed

The methodology and workloads for the educational products were already described in previous chapters. In the following, the modules and lectures for CPD are described.

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 will 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.

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 Table 10.

Table 10 – Content of CPD Module I - WEEE management | Key principles in e-waste management

Lecture number	Chapter	Main Content	Workload in teaching hours per semester
1.1	Policy and legislation for e-waste	Key principles: International aspects (e.g. Basel Convention etc.); European examples, Brazilian / Nicaraguan specifics	1.5
1.2	Sources and generation of e-waste	WEEE categories incl. typical items, types of e-waste generators	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	1
1.4	Collection and take-back systems	Formal and informal collection systems, retail, take-back by producers; best practice in Europe, Latin America, Asia	1.5
1.5	Material composition of different WEEE categories	Components, materials, valuable contents, hazardous material	2.5
1.6	De-pollution and dismantling	General aspects of depollution and dismantling	1.5
1.7	Mechanical processing	Fragmentation, separation, plant design	1
1.8	Specific treatment processes	Cathode ray tubes, flat panel displays, cables, lamps, printed circuit board treatment	1.5
1.9	Final treatment - recycling	Ferrous metals, non-ferrous metals, aluminium, plastics	1
1.10	Final treatment - disposal	Hazardous wastes, waste for disposal: Technologies, impacts etc., storage	1.5
		Total:	**14**

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. Table 11 displays the workload of the lectures in this module.

Table 11 - 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**

Practical Dismantling Module

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. To each partner university it is recommended to consider this option to provide extra incentives to take part in the courses. Each specific lecture (dismantling course for a specific WEEE category) is designed for 7 hours, i.e. one day. It is intended to provide a half day course on theoretical background and a half day for practical dismantling exercises in the LaWEEEda training centres (see Table 12).

Table 12 - Content of Practical dismantling courses

Lecture number	Chapter	Main Content	Workload in teaching hours per semester
3.1	Module Temperature exchange equipment	Refrigerators, Freezers, Air conditioning equipment	7
3.2	Screens and monitors	Screens, Televisions, Monitors, Laptops, Notebooks	7
3.3	Large equipment	Washing machines, Clothes dryers, Dish washing machines, Electric stoves	7
3.4	Small equipment	Vacuum cleaners Microwaves, Irons, Toasters, Clocks, Radio sets, Video cameras, Video recorders, Hi-fi equipment	7
3.5	Small IT and tele-communication equipment	Mobile phones, GPS, Pocket calculators, Routers, Personal computers, Printers, Telephones	7
		Total:	**35**