Έκθεση / Report

Assessment of the environmental impact of the project
Έκθεση αξιολόγησης του περιβαλλοντικού αντίκτυπου του έργου

Παραδοτέο της Δράσης C.2 (Περίληψη)
Deliverable of Action C.2 (Extended Summary)

LIFE Project Number
LIFE14 ENV/GR/000858

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"Assessment of the environmental impact of the project"

«Έκθεση αξιολόγησης του περιβαλλοντικού αντίκτυπου του έργου»

(Δράση C.2 / Action C.2)

Data Project

Project location	Greece, Belgium
Project start date:	01/01/2016
Project end date:	30/11/2020
Total budget	2.161.405 €
EC contribution:	1.247.300 €
(%) of eligible costs	60 %

Data Beneficiary

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Acronyms and Abbreviations

BoM	Bill of Material
FU	Functional unit
GHGs	Greenhouse gases
HDD	Hard Disk Drive
IC	Integrated Circuit
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
ODD	Optical Disc Drive
PCB	Printed Circuit Board
PWB	Printed Wiring Board
SC	Sorting center
WEEE	Waste Electrical and Electronic Equipment

Extended Summary

Background

The Life **RE-WEEE Project** aims to prevent the generation of Waste Electrical and Electronic Equipment (WEEE). In order to achieve this objective, two WEEE sorting centers (SCs) operated for the first time in Greece, in the wider region of Attika and Central Macedonia correspondingly. The core activity of those centers is the collection, the storage and the sorting of WEEE depending on their condition and then their preparing for reuse or treatment.

Objective

The main objective of this deliverable is to evaluate the environmental impact of the Project, performing a Life Cycle Assessment (LCA) for a selection of products that could be reused, thought the process of the WEEE sorting centers.

In summary, LCA is a tool for analyzing the potential environmental impacts of products/services at all stages of their life cycle. The term 'product/service life cycle' comprises the whole raw material acquisition, production, use, end-of-life treatment, recycling and final disposal processes.

In the SCs, the collected WEEE are transferred, stored and sorted after three control stages. The examined WEEE will be driven either for repair and reuse or recycling. Within the framework of the present LCA study, a total number of 6 types of WEEE will be examined, as decided according to the input flows data of the SCs.

The types of WEEE under examination are listed as following:

- Laptops
- Desktops
- Printers
- Smartphones
- Monitors
- Vacuum cleaners

Life Cycle Assessment

LCA Phases

LCA is a reliable and widespread method to address the environmental aspects and potential environmental impacts throughout a product's lifecycle. The principles, procedures and methods of LCA are presented based on the terminology and structure of the ISO 14040:2006 and 14044:2006.

According to those guidelines, LCA is composed of four phases (ISO 14040:2006):

- Goal definition and scope phase
- Inventory analysis phase
- Impact Assessment phase

- Interpretation phase

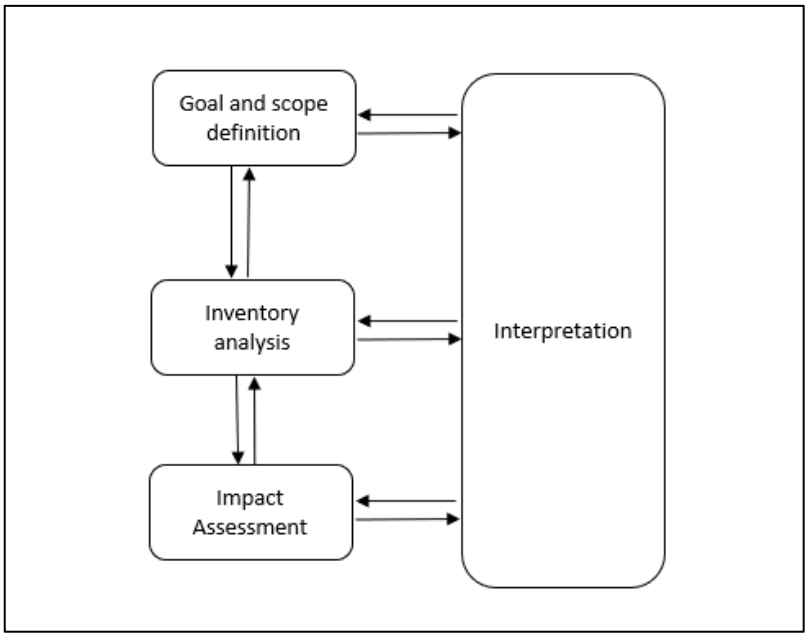

Figure 0-1: Life Cycle Assessment framework (Source: adapted from ISO 14040:2006)

As presented in Figure 0-1, there is an interactive relationship between the LCA phases. The evolution and results from each phase are linked directly to the other phases. A short description of each phase is described in the following sections.

Goal and scope definition

According to ISO 14040:2006, the definition of goal and scope is the first step in LCA and identifies the system under study, the intended results and the way the study will be directed. The determination of purpose and object is one of the most critical points of LCA because of their strong impacts on the results, so that they are agreeable with the overall objectives of the study.

During the goal definition, the following facts should be taken into account, (ISO 14040:2006):

- the proposed application;
- the reasons for carrying out the study,
- the expected audience,

During the scope definition, the following main facts should be taken into account, (ISO 14040:2006):

- the studied product system,
- the functions and processes of the product system,
- the functional unit,
- the product system boundaries,
- allocation procedures,
- LCIA methodology and types of impacts,

- interpretation to be used,
- data requirements,
- assumptions,
- value choices and optional elements,
- limitations,
- data quality requirements.

Inventory analysis

The Life Cycle Inventory analysis (LCI) is the second phase of an LCA study and involves the compilation and quantification of input and output data for the under-study product system.

The first sub-phase of the LCI analysis is composed of the collection of qualitative and quantitative data for all unit processes included in the product systems boundaries. In an LCI analysis and modeling, the main headings under which data may be classified include:

- energy inputs, raw material inputs, ancillary material inputs,
- products, co-products and waste,
- releases to air, water and soil

The second sub-phase of the LCI analysis includes calculation procedures of the collected data, including the confirmation of those data and the interrelation between them and the reference flow of the selected functional unit.

More specifically, for the products under examination, we will analyze the following:

a) the material use (resources) from production,
b) the energy/emissions (impacts) from production,
c) the impacts from their repair,
d) the potential benefits from the extension of their life cycle,
e) the energy/emissions (impacts) from end of life treatment.

Life Cycle Impact Assessment

The Life Cycle Impact Assessment (LCIA) is the third phase of the LCA. The purpose of LCIA is to provide additional information to help assess a product system's LCI results, to better understand their environmental significance.

This phase includes accounting, evaluating, and explanation the potential environmental impacts generated by the product through categorization and characterization of the flows.

More specifically, according to ISO 14044:2006, the LCIA phase shall include the following mandatory elements:

- **determination of impact categories**, category indicators and characterization models
- assignment of LCI results to the selected impact categories (**classification**)

- estimation of category indicator results (**characterization**)

The **selection of impact categories** reveals a comprehensive set of environmental issues associated with the studied product system, taking into consideration the goal and scope of the LCA analysis, as defined in the first phase. According to ISO 14040 and 14044, the evaluation of the environmental impacts of products may concern midpoint or endpoint indicators. Midpoint indicators focus on a single environmental problem, such as climate change, eutrophication, acidification, ozone depletion etc. Endpoint indicators present the environmental impacts of products life cycle on three main categories (Pré Consultants, 2000, Mousiopoulos, 1999):

- effect on human health
- biodiversity
- resource scarcity

The preference between midpoint or endpoint analysis depends on the goal and scope of each study.

During **classification**, information from the data inventory map to the impact categories, depending on the chosen method. For the most part, the calculated emissions contribute to more than one impact-category.

During the **characterisation**, the analysis, quantification and aggregation of environmental burdens and impacts belonging to the various individual categories are carried out. The characterization can be accessed by associating the information from data inventory according to the using method

Moreover, the need to compare the results between various impacts can be set to prioritize or to resolve interactions between alternative products. The comparison between impact category indices is an optional step in LCA, as mentioned in ISO 14040:2006, and can be achieved at the **normalization** stage.

The goal of normalization is twofold (Pennington et al, 2004):

- ✓ To place the results of the impact assessment in a wider context, and
- ✓ To adjust the results to have common dimensions.

Interpretation

The Life Cycle Interpretation is the final phase of the LCA procedure, in which the results of LCI and LCIA analysis are reviewed and evaluated as a basis for conclusions, recommendations and decision-making following the goal and scope definition.

Three main categories of activities have been identified (ISO 14040-14044:2006, Mousiopoulos, 1999, Koronaios, 2008) for the interpretation phase:

- identification of the significant issues based on the results of the LCI and LCIA phases of LCA
- evaluation that considers completeness, sensitivity and consistency checks
- conclusions, limitations, and recommendations

A key purpose of performing life cycle interpretation is to define the level of reliance on the final results and deliver them in a clear, exhaustive and precise manner (SETAC, 2002).

In the interpretation phase, a **sensitivity analysis** should be carried out, whereby various changes in the data are introduced deliberately, in order to determine the stability of the results in respect to these variations. The uncertainty analysis uses empirical data on the uncertainty ranges of specific data to calculate the overall error of the results. Sensitive analysis plays a significant role especially in the case of the data come from non-specific measurements.

Life Cycle Inventory Modeling

Basic concept

The processes allocated to each part & stage, is presented in the following Table.

Table 0-1: Processes allocated to each part & stage (printer)

Parts / Process		Manufacture	Repair	Reuse	End-of-Life
Materials / Parts production	Metals	X	X		
	Polymers	X	X		
	Polymers &Plastics	X	X		
	Cables &Plugs	X	X		
	TonerModules	X	X		
Energy Production	Assemply	X	X	X	
End-of-life	WEEE Treatment (dismantling)				X

The modeling was performed using SimaPro software (PRé Consultants, 2011) and MS excel.

As previously mentioned, for the products under examination, the following will be analyzed:

a) the material use (resources) from production,
b) the energy/emissions (impacts) from production,
c) the impacts from their repair,
d) the potential benefits from the extension of their life cycle,
e) the energy/emissions (impacts) from end of life treatment (dismantling).

Data for the production and end-of-life treatment (dismantling) of the laptop were sourced from ecoinvent database. Datasets are mainly derived from European industries from 2005 until now.

The information is based on literature data representing a typical printer of a leading producer. Regarding the Geographical scope of the database, the data is based on information by a leading international printer manufacturer. Such a printer may be assembled anywhere in the world, and therefore a global dataset is justifiable.

Regarding product repair and use, as previously presented in detail, the following data are used.

Table 0-2: Basic characteristics for modeling LCI of printer

Product	Average Lifetime (years)	Average Weight (kg)			Power Consumption		
		Other sources	SCs	Final	Old (kwh/y)	New (kwh/y)	Difference (%)
Printer	**4.00**	*5.80*	*23.95*	**14.88**	200.0	200.0	0%

Furthermore, based on the collected data regarding the use of replacement parts, the following percentages were taken into consideration.

Table 0-3: Estimated percentages of replacement parts for printer

Repair Type	Percentage (%)
Metals	25%
Polymers &Plastics	25%
Glass	25%
Cables &Plugs	2%
Toner Modules	10%
No significant action	13%
TOTAL	100%

In case of printers, since lifecycle impacts are mainly attributed to electricity consumtion, paper & cartriges during usage, sensitivity analysis was tested a larger energy consuption during use.