Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile

RawMaterials Hub
Regional Center Southern Italy

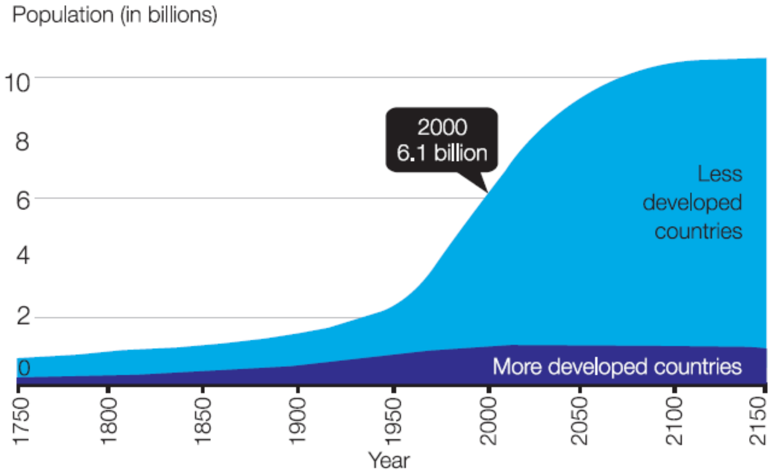
EIT RawMaterials Winter School
"Waste Electrical and Electronic Equipment"
26th - 30th October 2020

Recovery of materials from End-of-Life PV Panels in a Life Cycle Assessment perspective

Napoli, 29th October 2020

Amalia Zucaro, Gabriella Fiorentino SSPT-USER-T4RM

The economic system



Exploitation of natural resources and services

- Increasing levels of pollution
- Resource depletion
- Species loss and ecosystem degradation

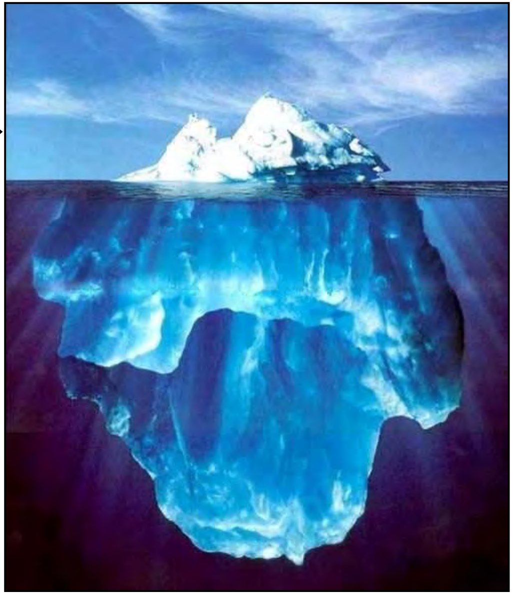
The economic system

LINEAR ECONOMY

- Resource extraction
- Production of goods and / or services
- End of life

‘Wasteberg’…what does it mean?

Municipal Waste
tip of the “wasteberg”



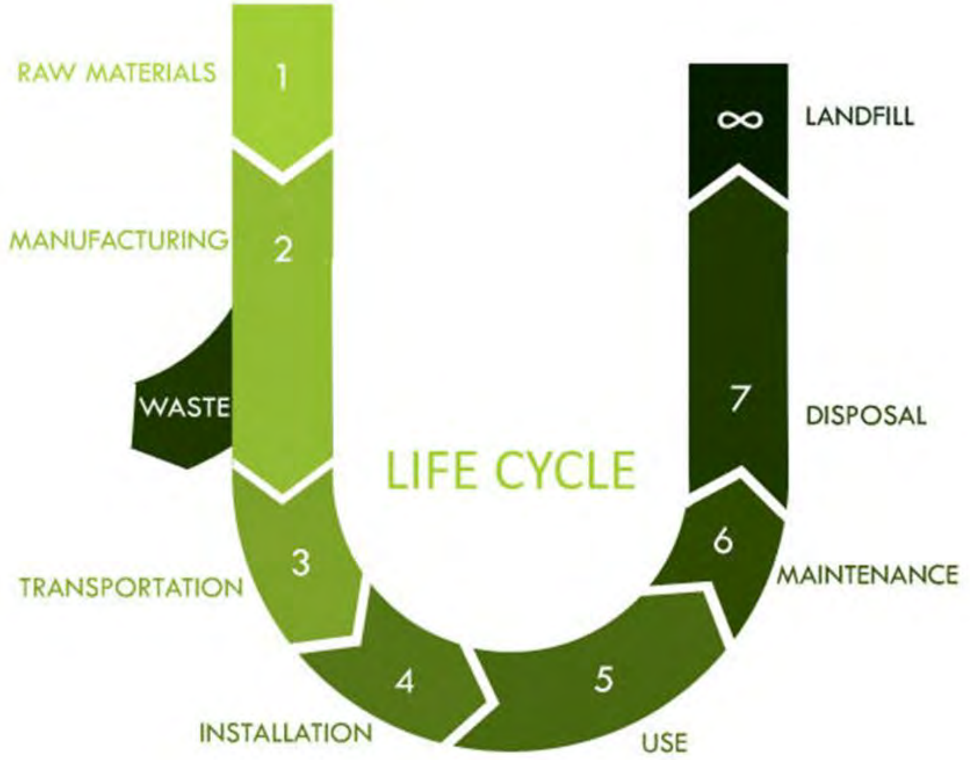
http://www.coopcentabc.org.br/documentos/incineracao/Zero_Waste_San_Francisco_EUA.pdf

- Municipal waste
- Supply chain waste
- Airborne and waterborne emissions
- Wastewaters

Upstream manufacturing waste
is 70 times greater

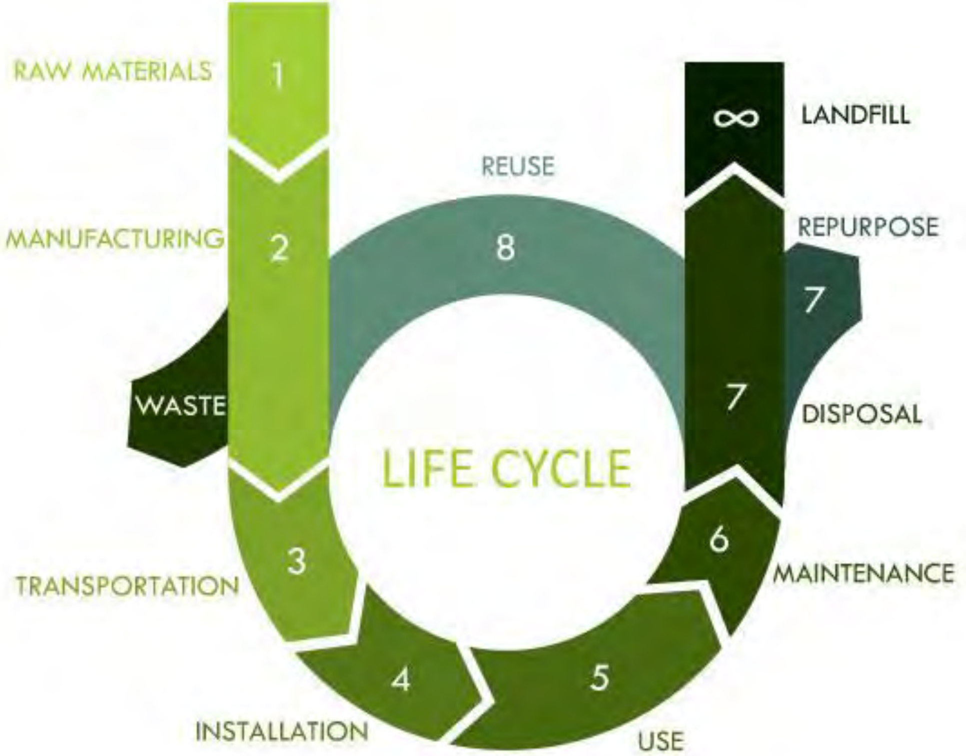
The search for solutions

From this…



The search for solutions

…to this



The search for solutions

THIS IS WHAT WE KNOW

Growing demand for goods

Unsustainable use of resources

Climate change is happening

Fossil energy supplies are dwindling

THIS IS WHAT THE CIRCULAR ECONOMY DOES…

Saves and values scarce resources

Cut GHG and environmental impacts

Makes the economy more sustainable

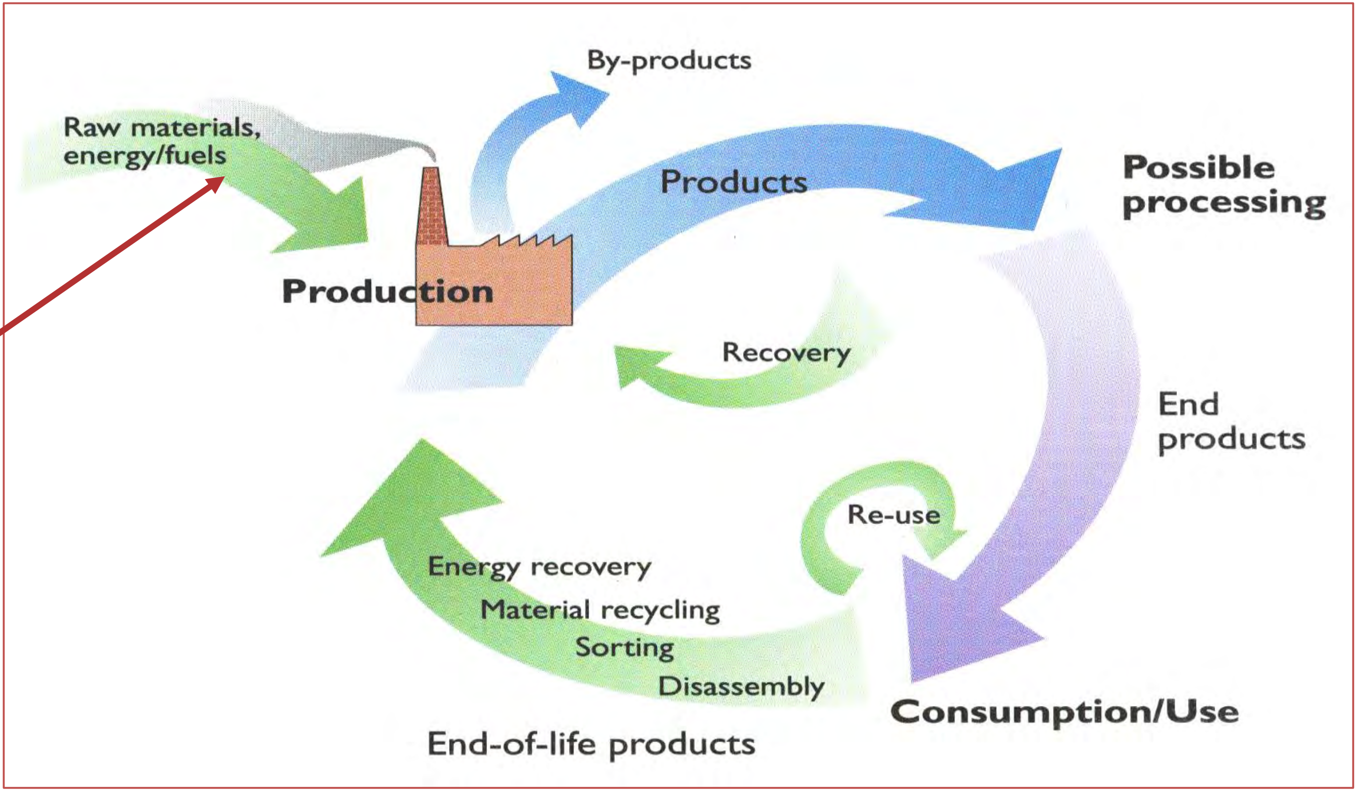
Creates new business opportunities and jobs

THIS IS THE OUTCOME…

The circular economy package brings the pieces together – production, consumption, secondary raw materials, waste management, innovation & investment- to cover the whole product lifecycle

Identify hotspots and alternatives in each process step

- Design,
- renewability,
- quality of sources,
- supply chain



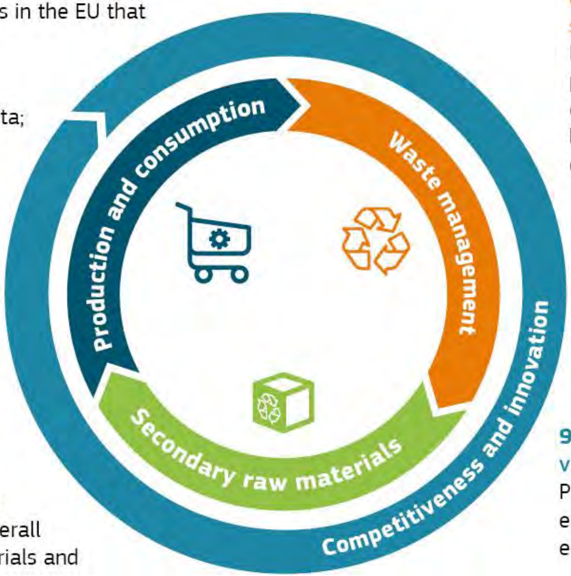
Circular economy monitoring framework

1 EU self-sufficiency for raw materials
The share of a selection of key materials (including critical raw materials) used in the EU that are produced within the EU

2 Green public procurement
The share of major public procurements in the EU that include environmental requirements

3a-c Waste generation
Generation of municipal waste per capita; total waste generation (excluding major mineral waste) per GDP unit and in relation to domestic material consumption

4 Food waste
Amount of food waste generated



5a-b Overall recycling rates
Recycling rate of municipal waste and of all waste except major mineral waste

6a-f Recycling rates for specific waste streams
Recycling rate of overall packaging waste, plastic packaging, wood packaging, waste electrical and electronic equipment, recycled biowaste per capita and recovery rate of construction and demolition waste

7a-b Contribution of recycled materials to raw materials demand
Secondary raw materials' share of overall materials demand - for specific materials and for the whole economy

8 Trade in recyclable raw materials
Imports and exports of selected recyclable raw materials

9a-c Private investments, jobs and gross value added
Private investments, number of persons employed and gross value added in the circular economy sectors

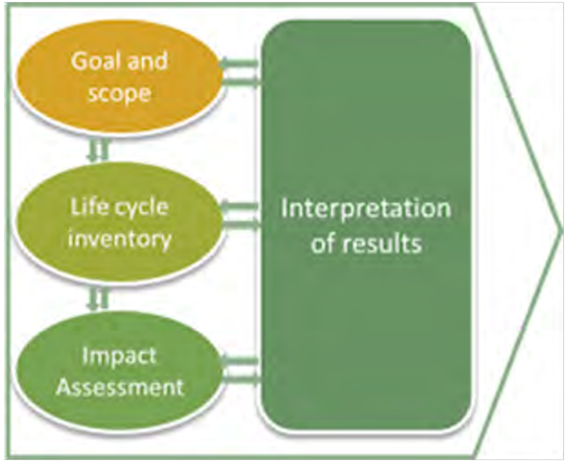
10 Patents
Number of patents related to waste management and recycling

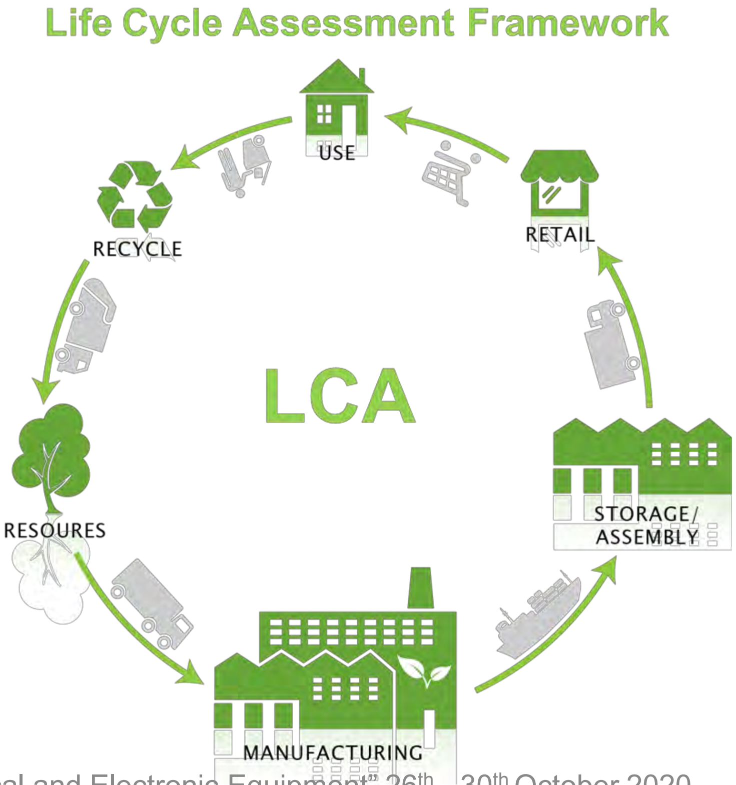
Source: COM(2018) 29 final

LIFE CYCLE THINKING

ISO 14040/44:2006

International Organization for Standardization

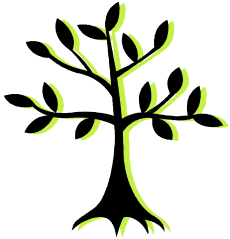


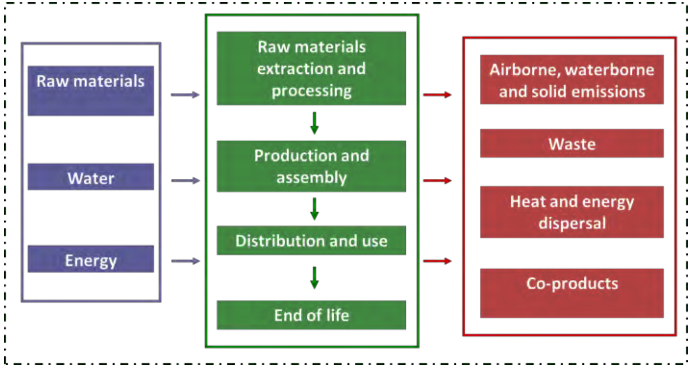


LIFE CYCLE THINKING

ENVIRONMENTAL SYSTEM

DEFINED AS THE SOURCE OF INPUT MATERIALS AND ENERGY AS WELL AS THE SINK OF ALL EMISSIONS





PRODUCT SYSTEM

DEFINED AS THE SET OF SUB-PROCESSES AND OPERATIVE STEPS HAVING THE FUNCTION OF GENERATING A USEFUL PRODUCT. IT IS SEPARATED FROM THE ENVIRONMENTAL SYSTEM BY WELL IDENTIFIED BOUNDARIES, BUT IT IS LINKED TO THE ENVIRONMENT THROUGH INPUT AND OUTPUT FLOWS.

LIFE CYCLE THINKING

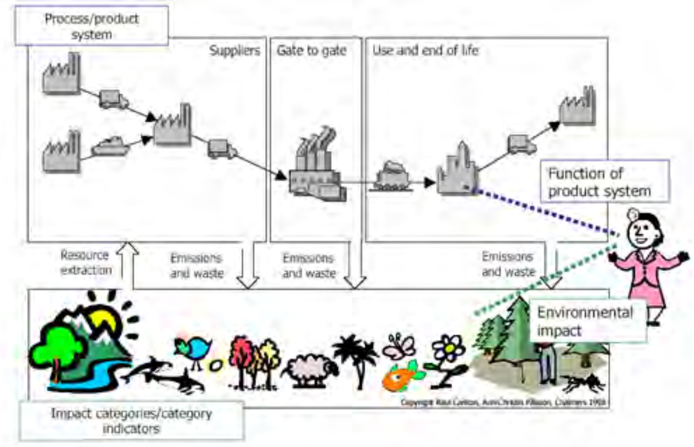
IMPACTS CAN BE DEFINED AT DIFFERENT LEVELS AND EVALUATION POINTS:

- MID POINT: BIOPHYSICAL EFFECTS

(acidification, eutrophication, etc);

- END POINT: DAMAGE EFFECTS

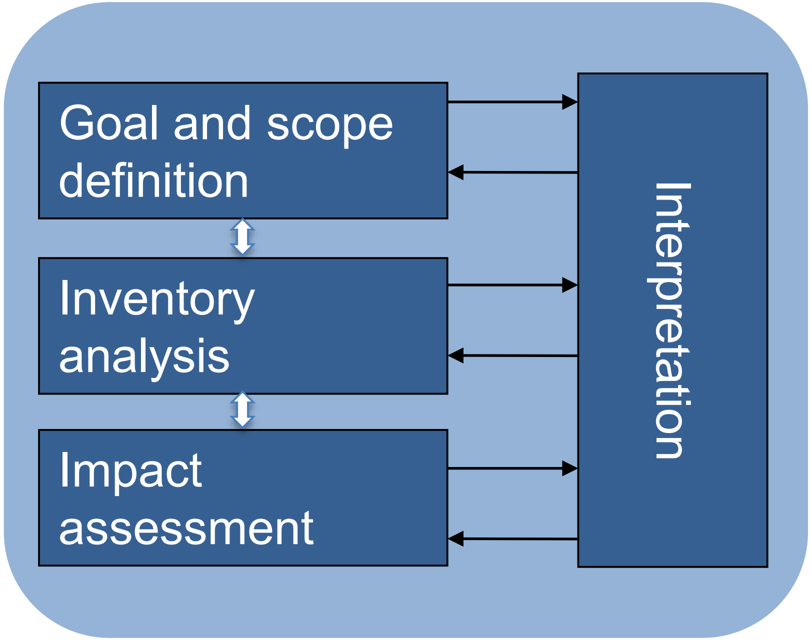
(biodiversity loss, health damage, etc).



In each impact category, impacts are quantified through indicators.

LIFE CYCLE ASSESSMENT (LCA)

1. GOAL AND SCOPE DEFINITION
2. INVENTORY ANALYSIS - LCI
3. IMPACT ASSESSMENT - LCIA
4. INTERPRETATION



LIFE CYCLE ASSESSMENT (LCA)

1. GOAL AND SCOPE DEFINITION

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4. INTERPRETATION

Goal and Scope definition

It is important to establish what purpose the model is to serve, what one wishes to study, what depth and degree of accuracy are required

Functional Unit

The functional unit defines the service that needs to be delivered

Boundaries

Physical, geographical, temporal

FUNCTIONAL UNIT

The functional unit measures the unit **functions provided** by the outputs in the investigated "product system" (i.e. represents what will be compared). It is based on the function, not on the product (careful consideration of a product/service life time is needed).

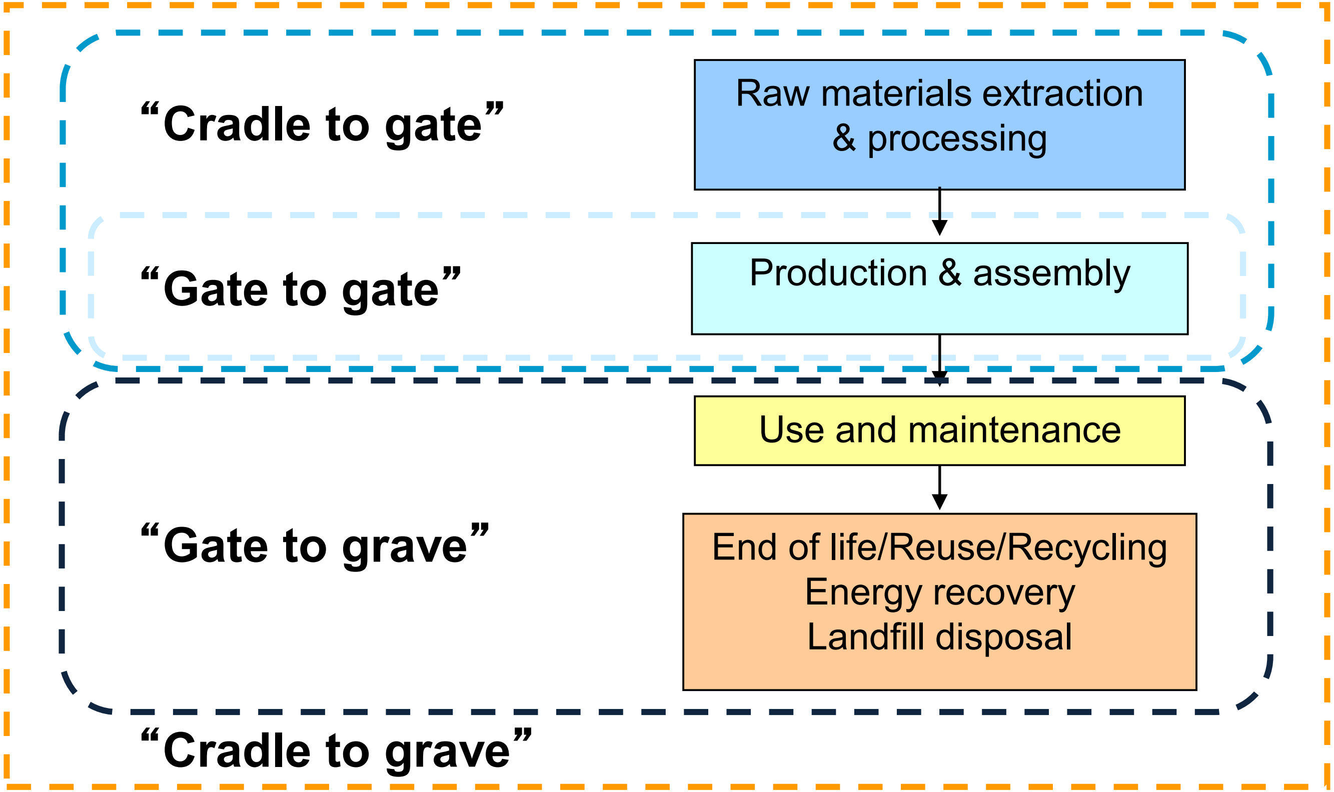
The function depends on the objective the systems and subsystems were designed for.

The REFERENCE FLOW must be defined for each elementary process.

↓

To be used in the INVENTORY (e.g. mass of inputs, volumes of gases, etc)

PHYSICAL BOUNDARIES



Cradle to grave – from mine to final disposal

Cradle to gate – From mine to product release

Gate to gate – only processing steps within the firm

Gate to grave – from product release to disposal after use, i.e. only after-production steps

Allocation

The allocation procedure must reflect a physical relation between flows and functions, in order to charge the impacts fairly and appropriately.

When data refer to a process characterized by two or more products, then we must decide which fraction of each input or output flow must be assigned to each output product or service (e.g. electricity and heat from a power plant).

This procedure is named ALLOCATION. The allocation should be avoided whenever this is possible. However, input flows and emissions can be partitioned to the products according to their mass, energy, exergy content, or economic value.

LIFE CYCLE ASSESSMENT (LCA)

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4. INTERPRETATION

PRIMARY DATA

data directly collected on field by the investigator, with and without the collaboration of process operators

SECONDARY DATA

data representative of the process/sector dynamics, collected from literature or databases

DATA COLLECTION

PRIMARY DATA **data directly collected on field by the investigator, with and without the collaboration of process operators.**

SECONDARY DATA **data representative of the process/sector dynamics, collected from literature or databases**

DATA SOURCE	IMPORTANT FEATURES
REAL PROCESSES	Questionnaires, reports, manuals, agreements, comunication tools
MODELS, ESTIMATES	Process models, extrapolation procedures, similarities with other models, assumptions, ecc
DATABASES, LITERATURE	Transparent structure, price of data sources, copyright, applicability
RESTRICTED DATABASES AND SOURCES	Confidentiality agreements, possibility to publish.

LIFE CYCLE ASSESSMENT (LCA)

1. GOAL AND SCOPE DEFINITION

2. INVENTORY ANALYSIS - LCI

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4. INTERPRETATION

OpenSource software

- OpenLCA
- Quantis SUITE 2.0

Commercial software

- GaBi
- SimaPro
- Umberto LCA+
- EIME
- TEAM

SimaPro software

Produced by PRé Consultants

Integrates with vaious databases,

Uses a more text/menu approach to modelling, rather than graphical approach

- Though graphical flowcharts can be viewed following data input

Calculates results using matrix inversion

For use by professionals at two levels (Analyst or Developer)

Server based, convenient for multiple users and for remote connection

SimaPro - Databases

SimaPro includes various databases

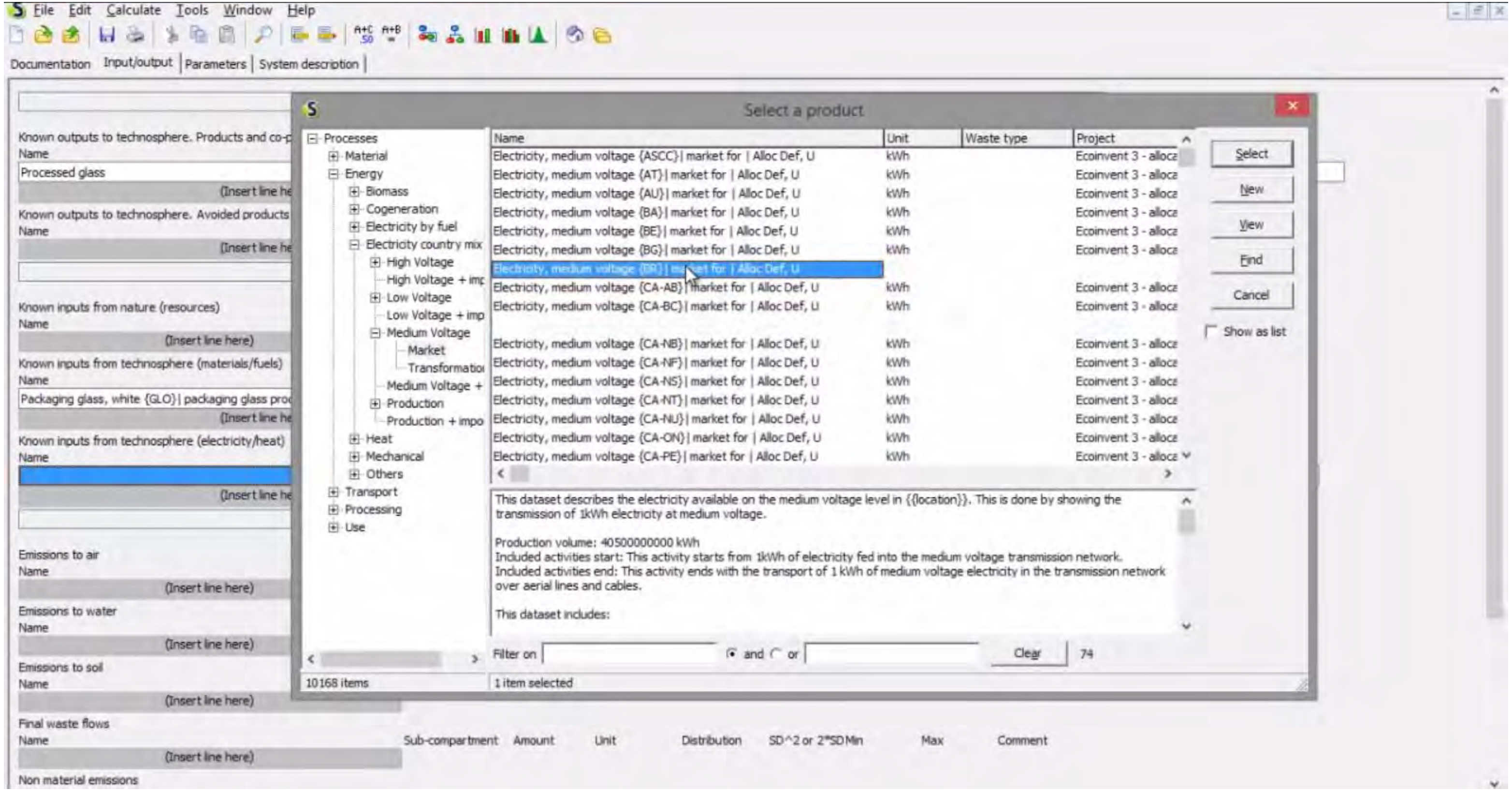
Agri-footprint	AGRIBALYSE (optional)	DATASMART LCI package (optional)
ecoinvent (included by default, optional on request)	ELCD	Environmental Footprint database (optional)
ESU world food LCA database (optional)	European and Danish Input/Output database	EXIOBASE (optional)
IDEA Japanese Inventory database (optional)	Industry data library: PlasticsEurope, ERASM, World Steel	Social hotspots database (optional)
Swiss Input/Output database	US Life Cycle Inventory database	WEEE LCI database (optional)

SimaPro - Methods

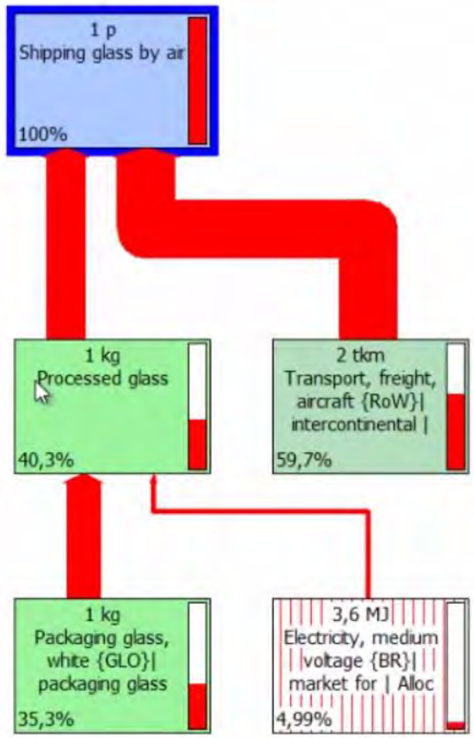
SimaPro includes various methods

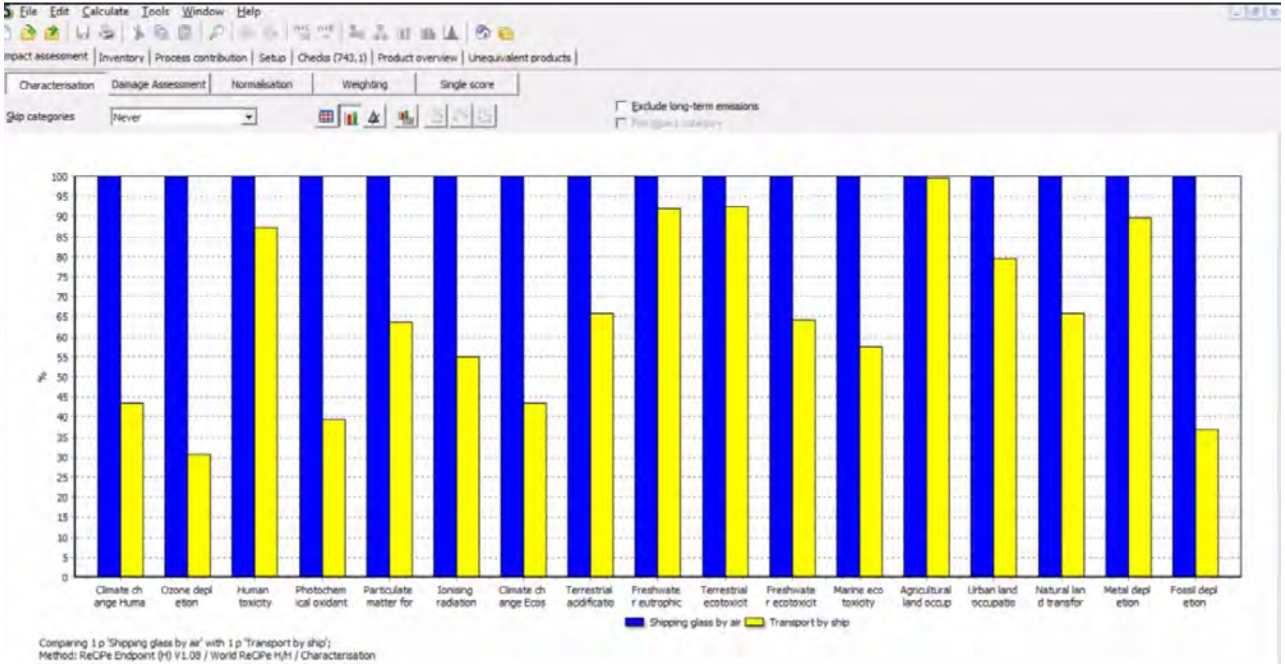
AWARE	BEES+	Berger et al 2014 (Water Scarcity)
Boulay et al 2011 (Human Health)	Boulay et al 2011 (Water Scarcity)	CML-IA
Cumulative Energy Demand (CED)	Cumulative Energy Demand (LHV)	Cumulative Exergy Demand
Ecological Scarcity 2006 (Water Scarcity)	Ecological scarcity 2013	Ecosystem Damage Potential
EDIP 2003	EF Method (adapted)	Environmental Footprint (EF)
Environmental Prices	EPD 2018	EPS 2015d/ dx
Greenhouse Gas Protocol	Hoekstra et al 2012 (Water Scarcity)	ILCD 2011 Midpoint+
IMPACT 2002+	IPCC 2013	Motoshita et al 2010 (Human Health)
Pfister et al 2009 (Eco-indicator 99)	Pfister et al 2009 (Water Scarcity)	Pfister et al 2010 (ReCiPe)
ReCiPe 2016 Endpoint	ReCiPe 2016 Midpoint	Selected LCI results
TRACI 2.1	USEtox 2	

SimaPro - Inputs

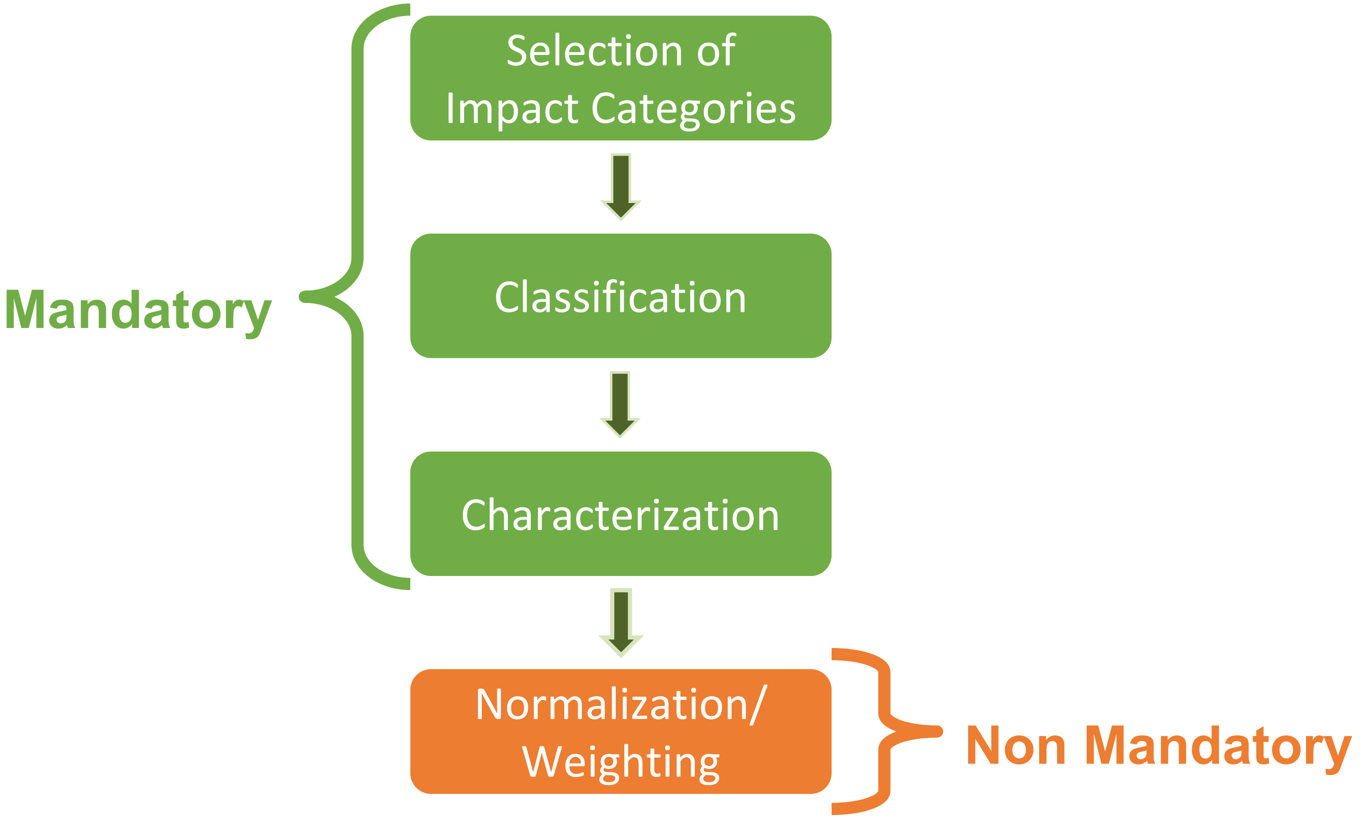


SimaPro - Outputs



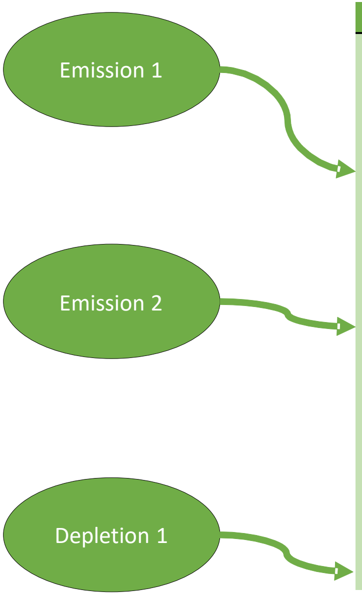


Life Cycle Impact Assessment

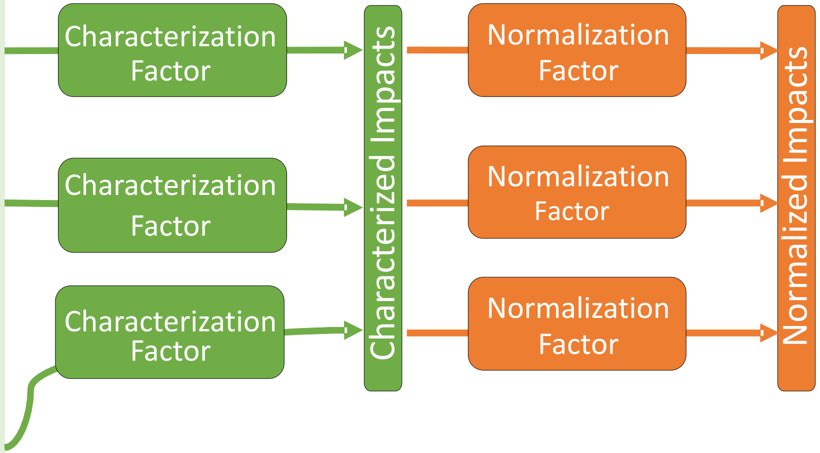


Life Cycle Impact Assessment

Recipe Midpoint H Impact Method



Impact Category	Unit
Fine particulate matter formation potential	kg $PM_{2.5}$ eq
Fossil resource scarcity potential	kg oil eq
Freshwater ecotoxicity potential	kg 1,4-DCB
Freshwater eutrophication potential	kg P eq
Global warming potential	kg CO_2 eq
Human carcinogenic toxicity potential	kg 1,4-DCB
Human non-carcinogenic toxicity potential	kg 1,4-DCB
Ionizing radiation potential	kBq Co-60 eq
Land use potential	m^2a crop eq
Marine ecotoxicity potential	kg 1,4-DCB
Marine eutrophication potential	kg N eq
Mineral resource scarcity potential	kg Cu eq
Ozone formation, Human health potential	kg NO_x eq
Ozone formation, Terrestrial ecosystems potential	kg NO_x eq
Stratospheric ozone depletion potential	kg CFC11 eq
Terrestrial acidification potential	kg SO_2 eq
Terrestrial ecotoxicity potential	kg 1,4-DCB
Water consumption potential	m^3



Life Cycle Impact Assessment

POLLUTANTS DYNAMICS

THREE (3) MAIN FACTORS

EMISSION

Release of noxious substances

TRANSMISSION

Substances undergo physico-chemical changes after being released to the environment

IMMISSION

Concentration or deposition of pollutants in their final destination site

Life Cycle Impact Assessment

Global impacts - G

Local impacts - L

Regional impacts -R

Photochemical oxidation

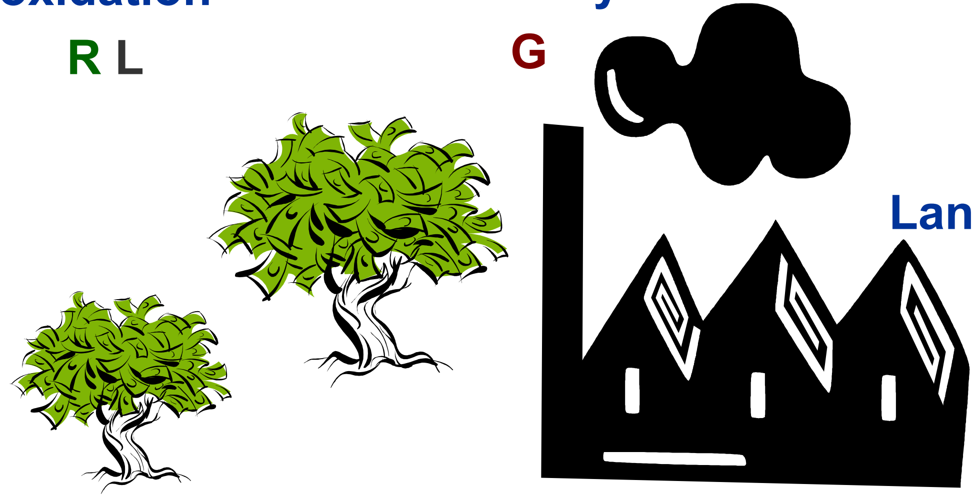
R L

Ozone layer

G

Global warming

G



Land degradation

L

Toxicity

R L

Eutrophication

R

Acidification

R

Resource depletion

G

LIFE CYCLE ASSESSMENT (LCA)

1. GOAL AND SCOPE DEFINITION

2. INVENTORY ANALYSIS - LCI

3. IMPACT ASSESSMENT - LCIA

4. INTERPRETATION

INTERPRETATION

Once the system has been analysed, this step aims at verifying if results are consistent with the goal and scope and if the procedure fits the ISO standards. Then improvements are suggested to minimize the environmental load.

Case study – the ReSiELP project

ReSiELP

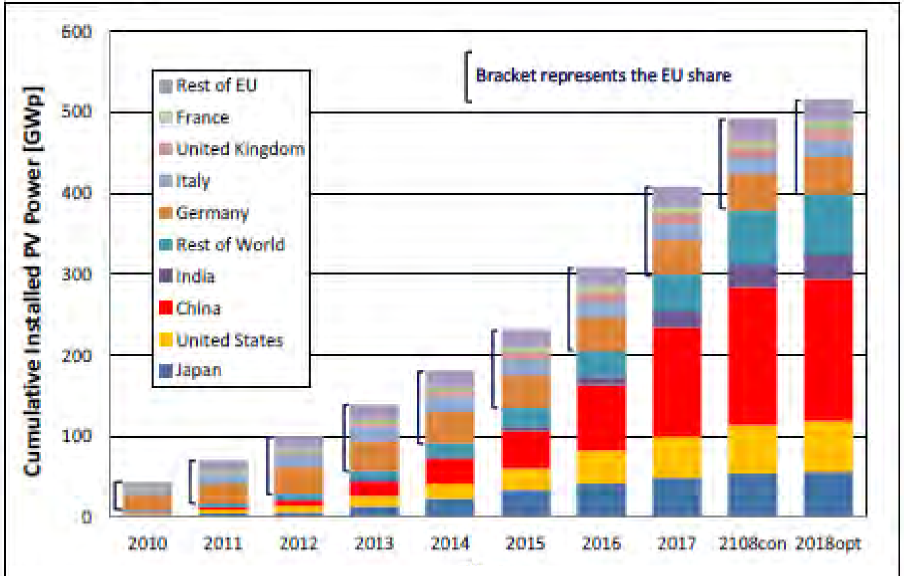
Supported by

eit RawMaterials
Connecting matters

This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

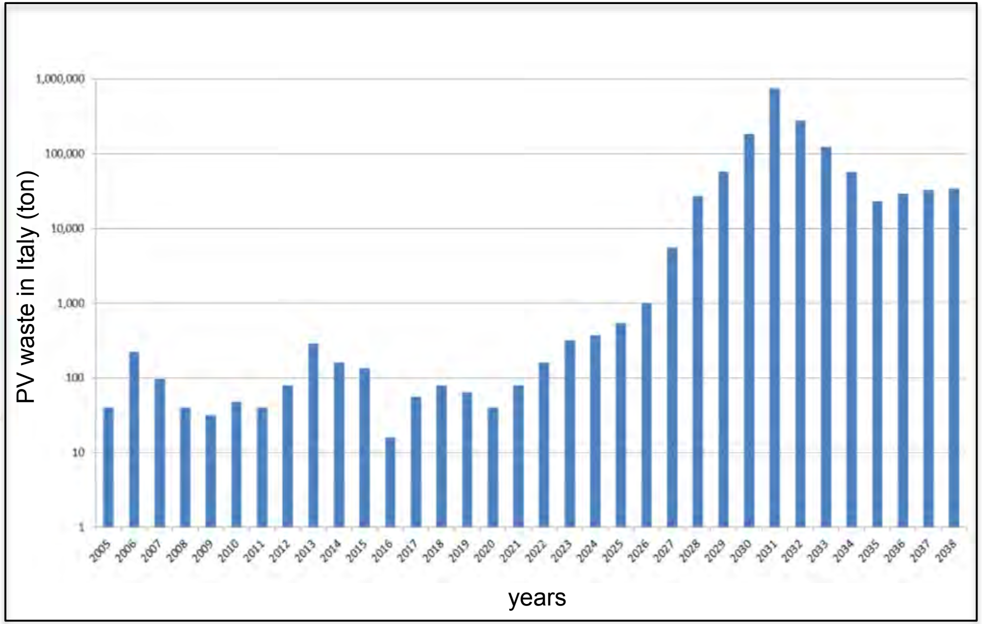
Recovery of Silicon and other materials from End-of-Life Photovoltaic Panels

General context



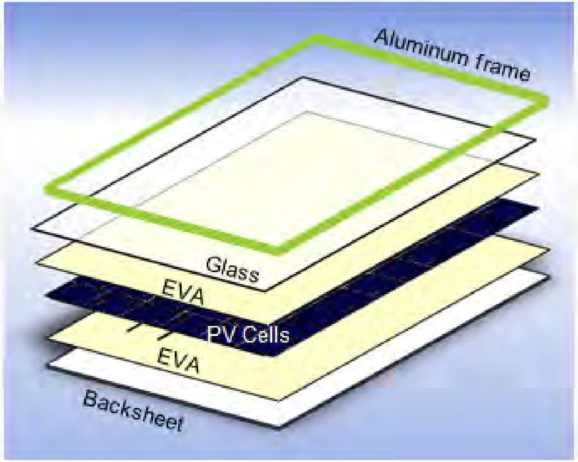
Source: IEA PVPS, 2017 Snapshots of global PV markets, Report IEA PVPS T133:2018, April 2018, ISBN 978–3–906042-72-5

PV panels lifetime: ~ 25-30 years
Cumulative EoL PV panels waste should exceed 60 million tonnes by 2050



EoL PV panels management: opportunity and challenge

VALUE CREATION & IMPLEMENTATION OF A CIRCULAR VALUE-CHAIN



Main challenge
Recovering and valorisation of valuable material

Al, Glass, Si, Ag, Cu

Recycling process

- Thermal
- Chemical
- Mechanical

EoL PV panels management: opportunity and challenge

Production per day – 108 kg PV panels
(36 ton/y)

Glass:
76 kg

Aluminium:
18 kg

Silicon:
1.3 kg

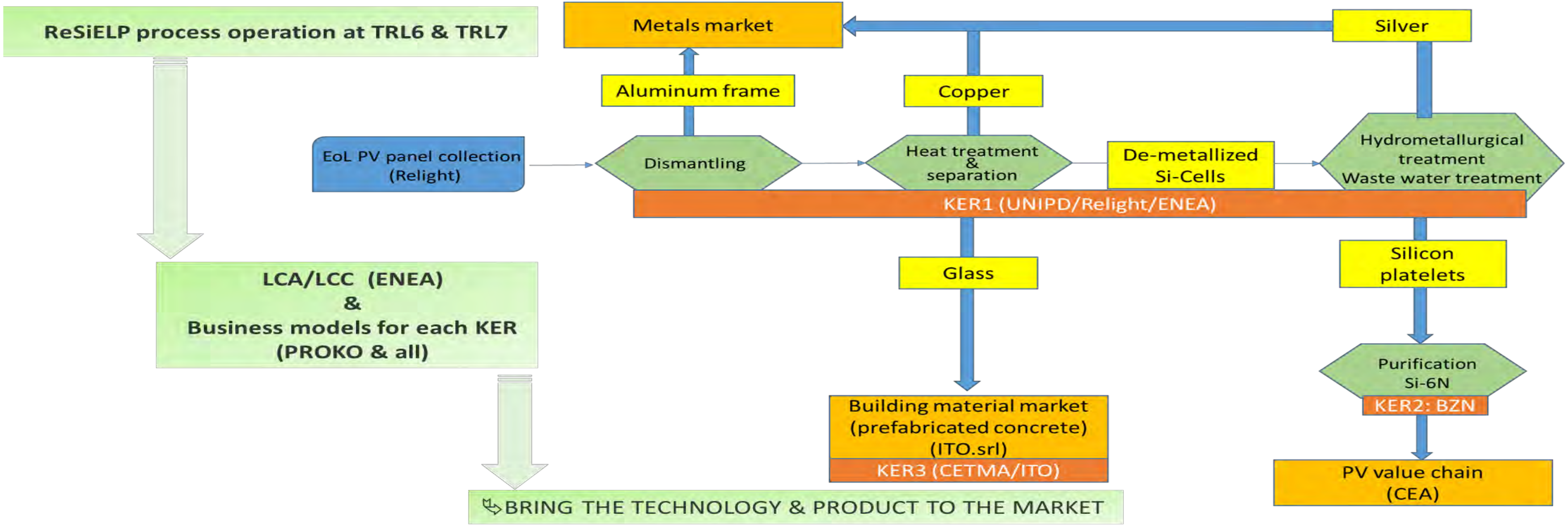
Copper:
0.75 kg

Silver:
0.012 kg

Glass	Aluminium	Silicon	Copper	Silver
23.7 ton/y	4.4 ton/y	450 kg/y	317 kg/y	14 kg/y

ReSiELP value chain

Recovery and valorization of materials (Si, Ag, Al, Cu and glass)



LCA of ReSiELP recovery process

1. GOAL AND SCOPE DEFINITION

The objectives of this LCA study are:

- identifying environmental hotspots and opportunities to improve the environmental performances (e.g. by reducing environmental loads) of the following processes:
  - from dismantling up to hydrometallurgical treatments, carried out at Relight plant – Recovery line (Northern Italy)
  - use of the recovered glass as inert in the concrete prefabricated building elements (predalles), implemented at ITO plant – Glass reuse line (Southern Italy)
  - silicon purification process, carried out at Bay Zoltan plant – Si purification line (Hungary)
- giving a general overview on the environmental performances of the developed recovery process.

LCA of ReSiELP recovery process

1. GOAL AND SCOPE DEFINITION

The systems under study are two:

A. System A, including two different lines: 1) the Recovery line and 2) the Glass reuse line. The function of this system consists in recovering/extracting aluminium, glass, copper, silver and silicon (2N purity grade) from EoL PV c-Si modules and in reusing the recovered glass in the Building & Construction sector;

B. System B, related to the purification of silicon, from 4N to 6N purity grade. The function of this system consists in purifying silicon, so that it can be reused for the production of new PV panels.

LCA of ReSiELP recovery process

1. GOAL AND SCOPE DEFINITION

*SYSTEM A - FUNCTIONAL UNIT **(F.U.)***:

24 ton of EoL PV c-Si panels = 16.8 ton of recycled Glass = 654 predalles

Recovery line

Glass reuse line

*SYSTEM B - FUNCTIONAL UNIT **(F.U.)***:

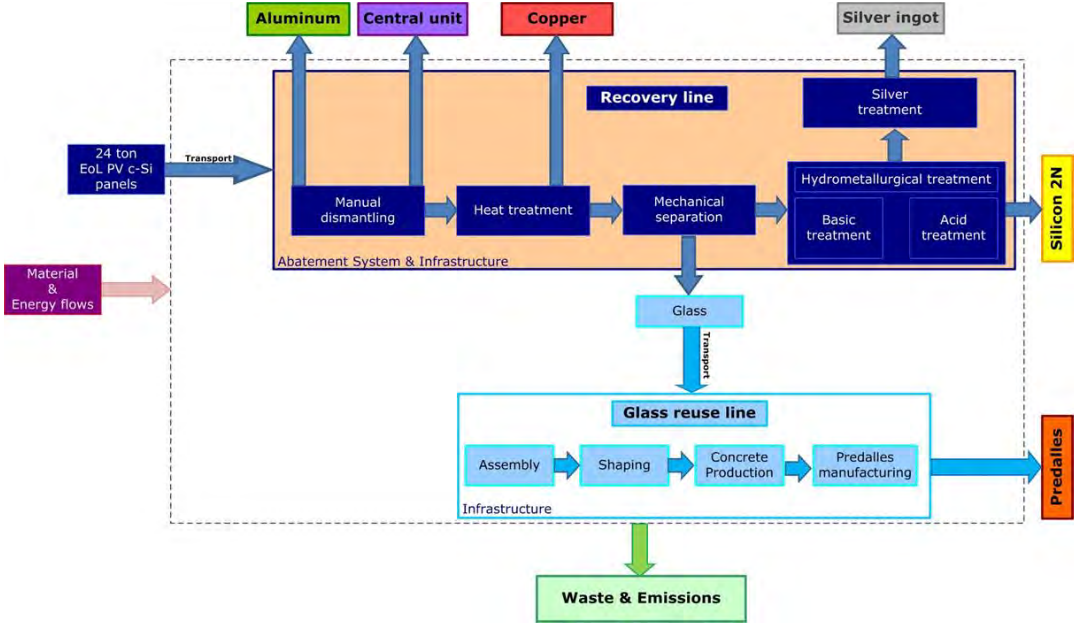
24 ton of EoL PV c-Si panels = 0.255 ton of Si 4N

(after a Si purification step up to 4N, with 80% assumed yield)

LCA of ReSiELP recovery process

1. GOAL AND SCOPE DEFINITION

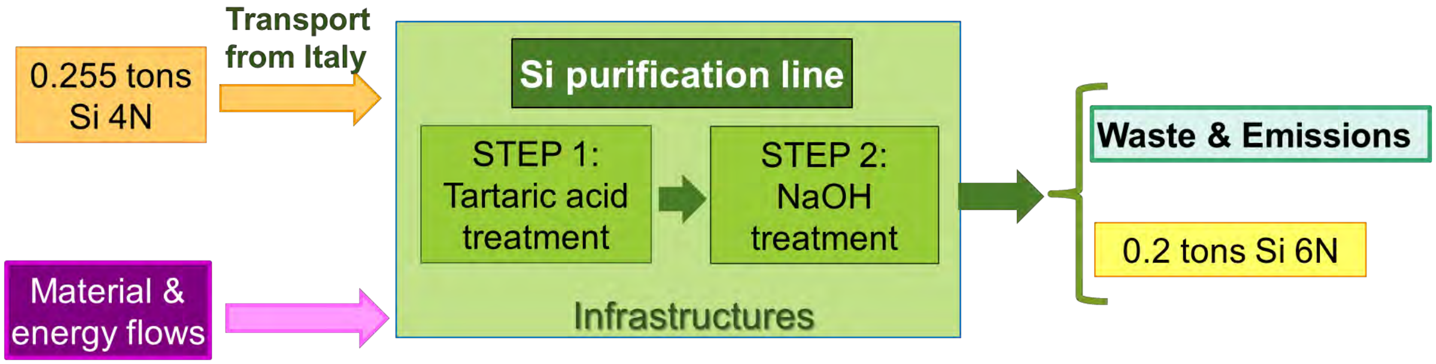
SYSTEM A – SYSTEM BOUNDARY



LCA of ReSiELP recovery process

1. GOAL AND SCOPE DEFINITION

SYSTEM B – SYSTEM BOUNDARY



LCA of ReSiELP recovery process

2. INVENTORY ANALYSIS - LCI

- Primary data from direct surveys
- Secondary data from literature (scientific papers and databases)
- Tertiary data from estimates and similar operations, environmental statistics and average values.

LCA of ReSiELP recovery process

ReCiPe H Midpoint method

(Huijbregts *et al.*, 2016. ReCiPe 2016 A harmonized life cycle impact assessment method at midpoint and endpoint level. Report I: Characterization. RIVM Report 2016-0104. National Institute for Public Health and the Environment)

3. IMPACT ASSESSMENT - LCIA

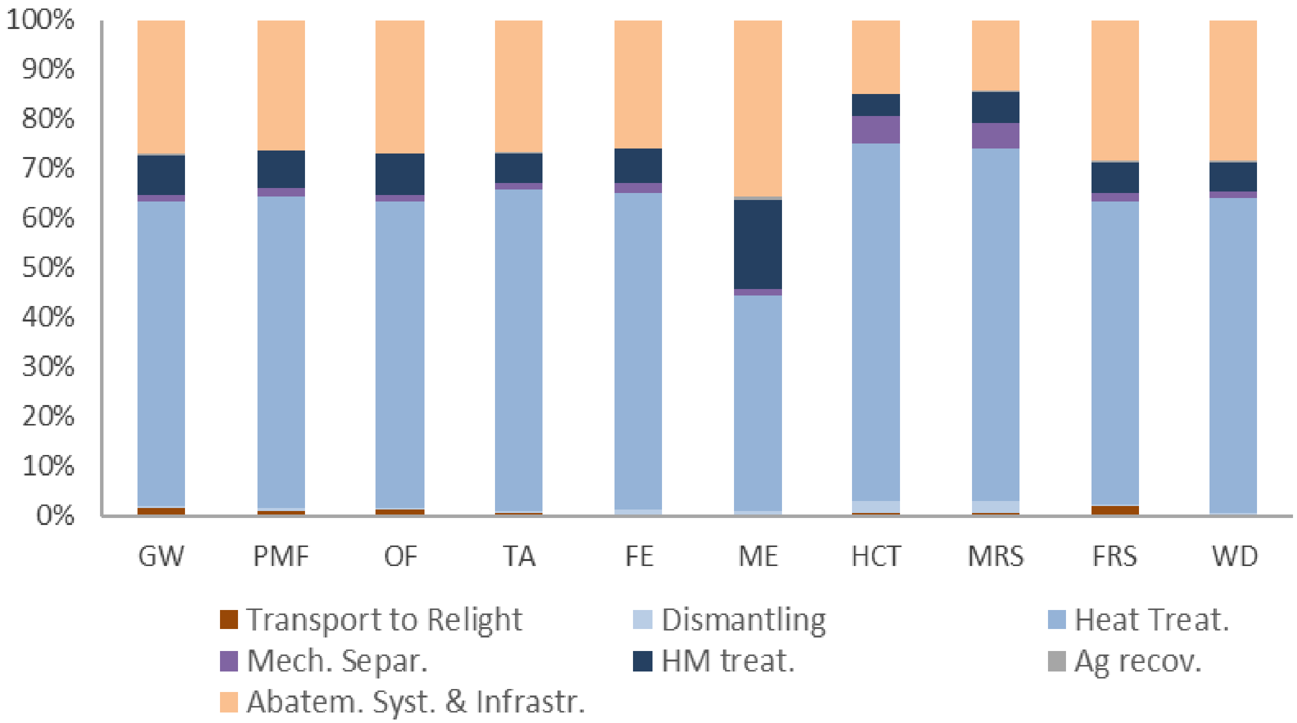
Which environmental impact categories were considered?

global warming (GW), fine particulate matter formation (PMF), ozone formation, terrestrial ecosystems (OF), terrestrial acidification (TA), freshwater eutrophication (FE), marine eutrophication (ME), human carcinogenic toxicity (HCT), mineral resource scarcity (MRS), fossil resource scarcity (FRS) and water consumption (WD)

LCA of ReSiELP recovery process

SYSTEM A – Characterised impacts from the Recovery line

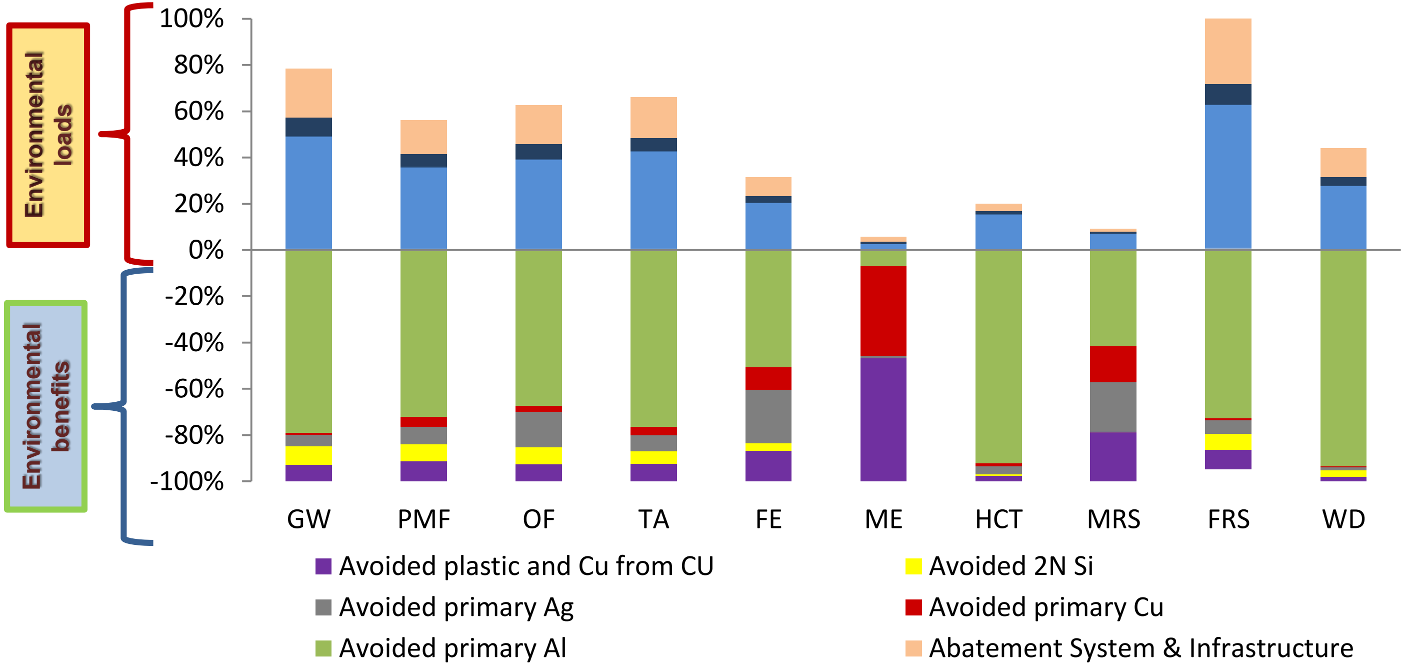
	Total	Unit
GW	3.36E+04	kg CO_2 eq
PMF	5.23E+01	kg PM2.5 eq
OF	7.10E+01	kg NO_x eq
TA	1.56E+02	kg SO_2 eq
FE	1.24E+01	kg P eq
ME	1.49E+00	kg N eq
HCT	2.30E+03	kg 1,4-DCB
MRS	1.59E+02	kg Cu eq
FRS	9.54E+03	kg oil eq
WD	6.03E+02	m^3



LCA of ReSiELP recovery process

SYSTEM A – Characterised NET impacts from the Recovery line

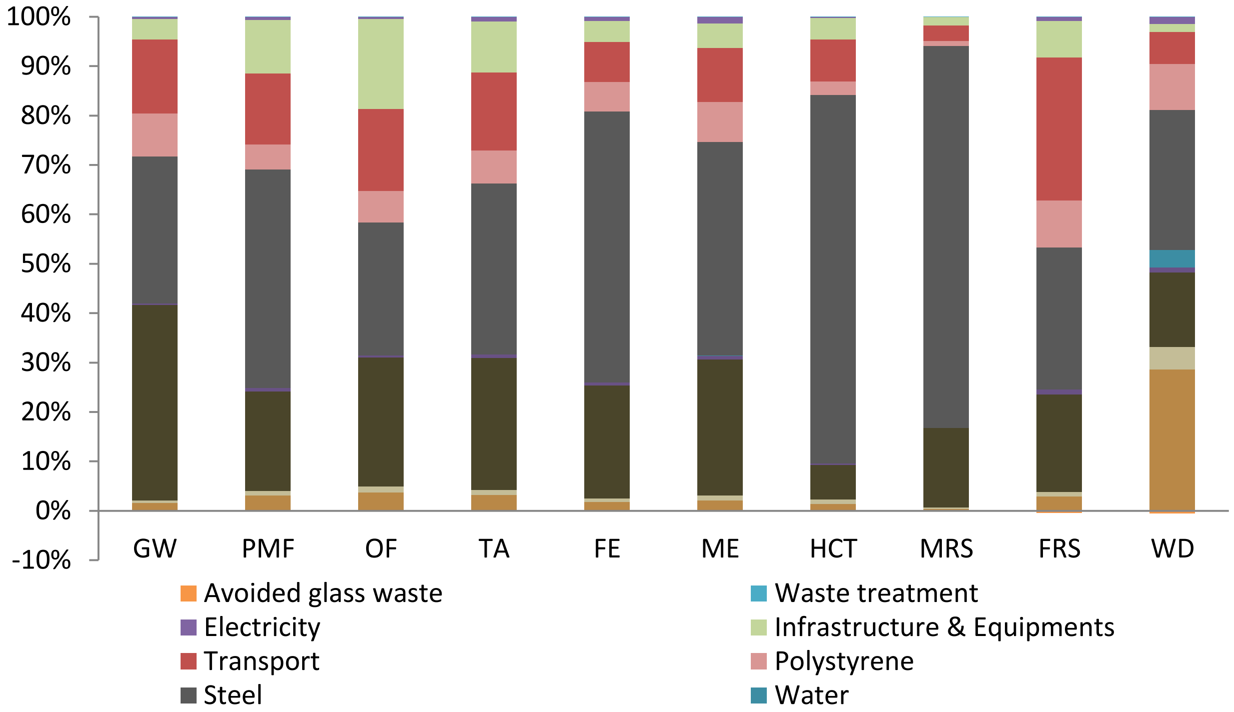
	Total	Unit
GW	-9.23E+03	kg CO_2 eq
PMF	-4.09E+01	kg PM2.5 eq
OF	-4.24E+01	kg NO_x eq
TA	-8.03E+01	kg SO_2 eq
FE	-2.71E+01	kg P eq
ME	-2.43E+01	kg N eq
HCT	-9.26E+03	kg 1,4-DCB
MRS	-1.55E+03	kg Cu eq
FRS	5.12E+02	kg oil eq
WD	-7.67E+02	m^3



LCA of ReSiELP recovery process

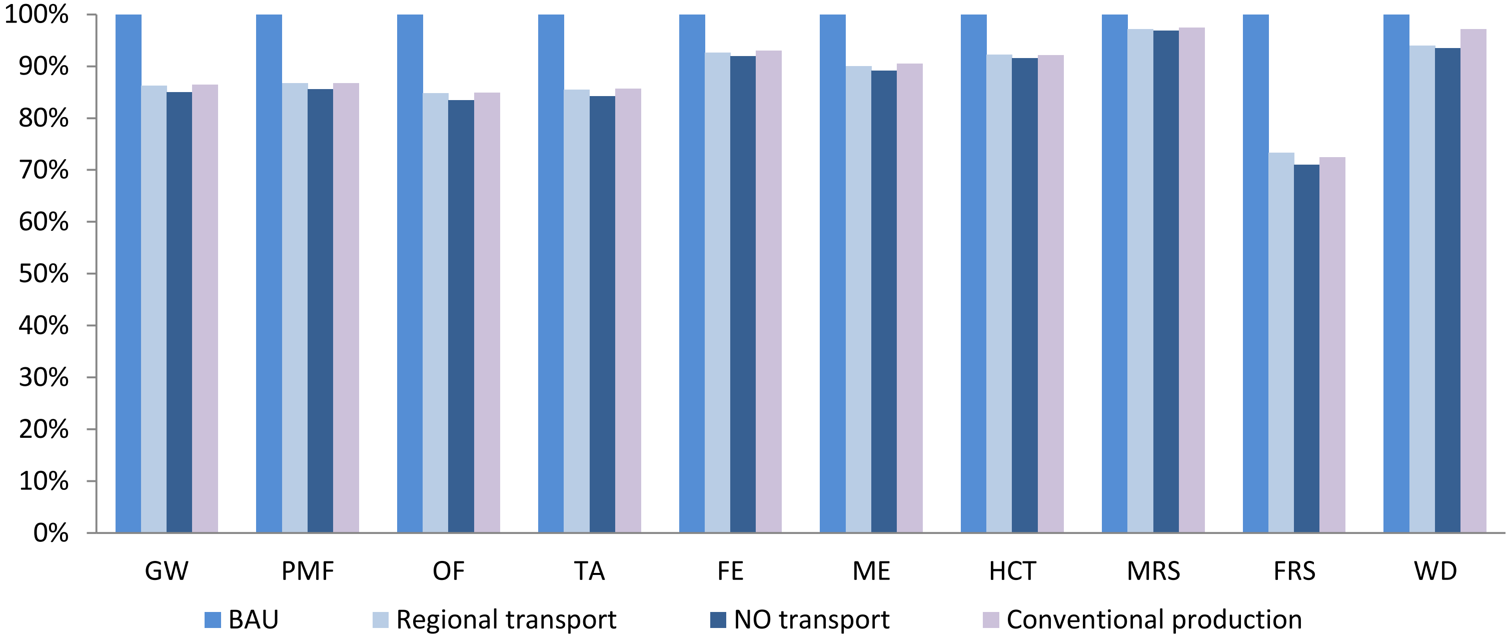
SYSTEM A – Characterised impacts from the Glass reuse line

	Total	Unit
GW	7.16E+04	kg CO_2 eq
PMF	7.82E+01	kg PM2.5 eq
OF	1.82E+02	kg NO_x eq
TA	1.67E+02	kg SO_2 eq
FE	1.42E+01	kg P eq
ME	8.06E-01	kg N eq
HCT	3.89E+03	kg 1,4-DCB
MRS	9.58E+02	kg Cu eq
FRS	1.24E+04	kg oil eq
WD	4.79E+02	m^3



LCA of ReSiELP recovery process

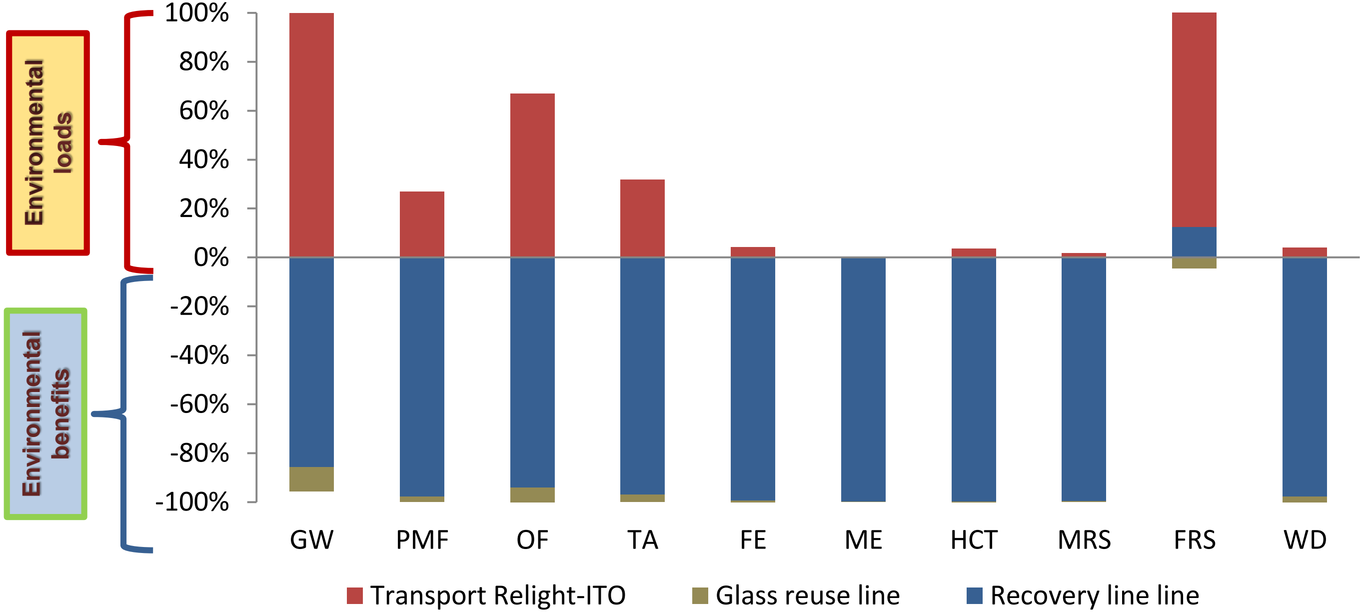
SYSTEM A – Transport scenarios in the Glass reuse line



LCA of ReSiELP recovery process

SYSTEM A – Characterised NET impacts from the System A

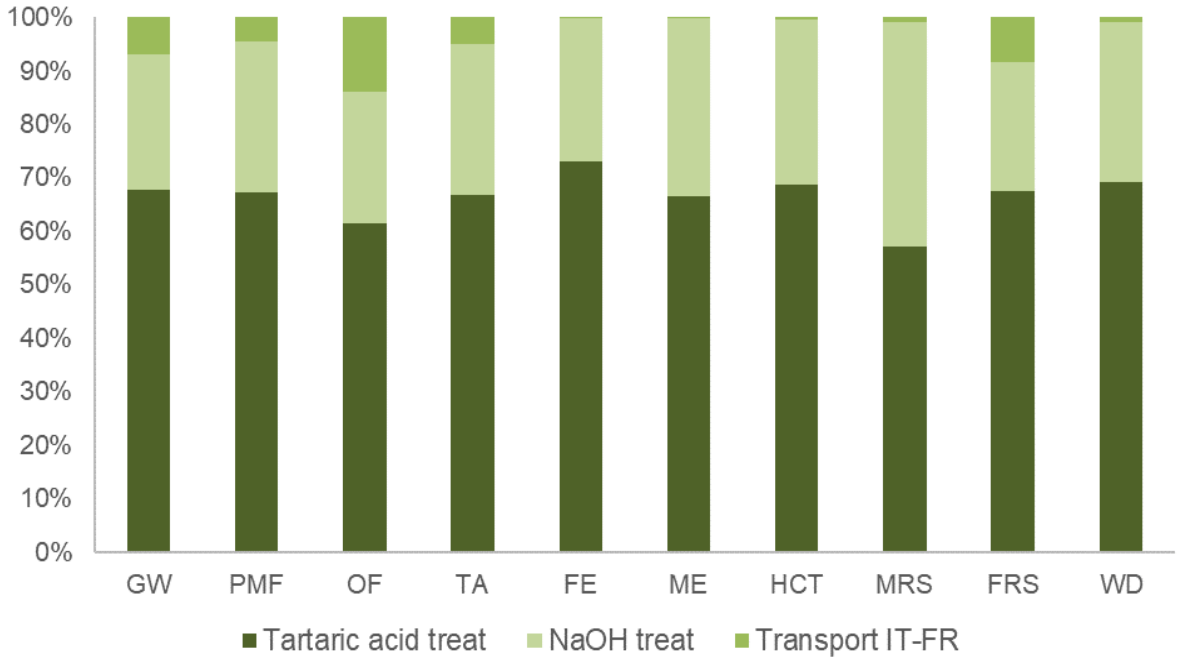
	Total	Unit
GW	4.66E+02	kg CO_2 eq
PMF	-3.06E+01	kg PM2.5 eq
OF	-1.48E+01	kg NO_x eq
TA	-5.64E+01	kg SO_2 eq
FE	-2.61E+01	kg P eq
ME	-2.42E+01	kg N eq
HCT	-8.95E+03	kg 1,4-DCB
MRS	-1.52E+03	kg Cu eq
FRS	3.92E+03	kg oil eq
WD	-7.53E+02	m^3



LCA of ReSiELP recovery process

SYSTEM B – Characterized impacts from the Si purification

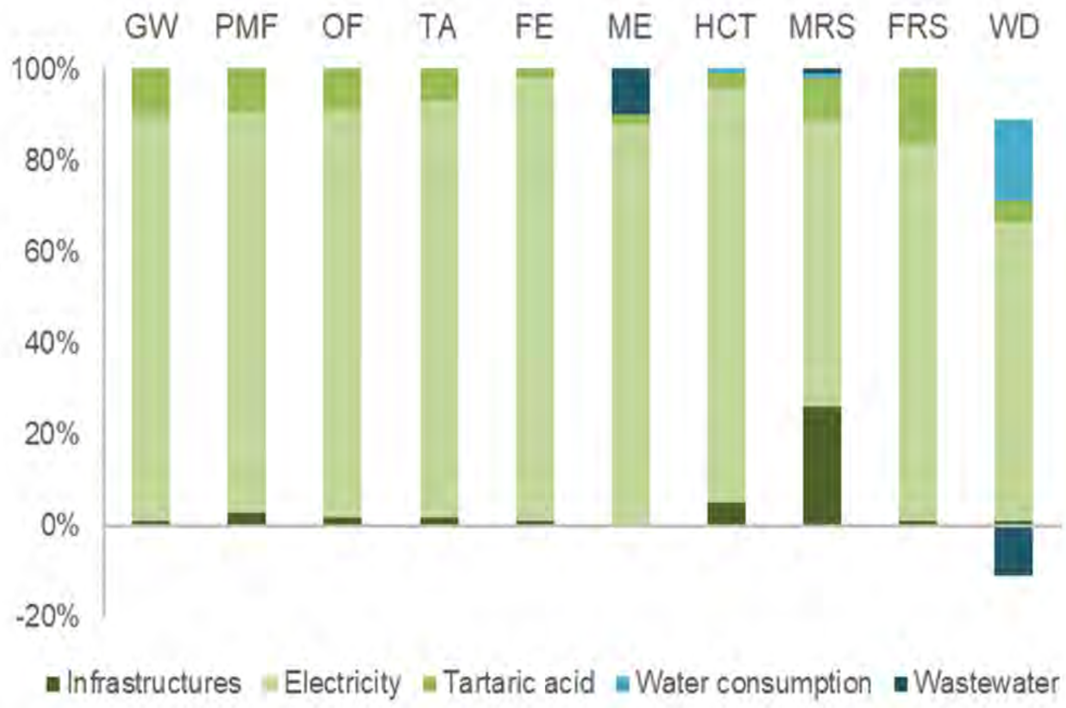
	Total	Unit
GW	2.47E+03	kg CO_2 eq
PMF	3.61E+00	kg PM2.5 eq
OF	5.37E+00	kg NOx eq
TA	9.79E+00	kg SO_2 eq
FE	3.06E+00	kg P eq
ME	2.62E-01	kg N eq
HCT	1.91E+02	kg 1,4-DCB
MRS	5.54E+00	kg Cu eq
FRS	6.77E+02	kg oil eq
WD	2.89E+01	m^3



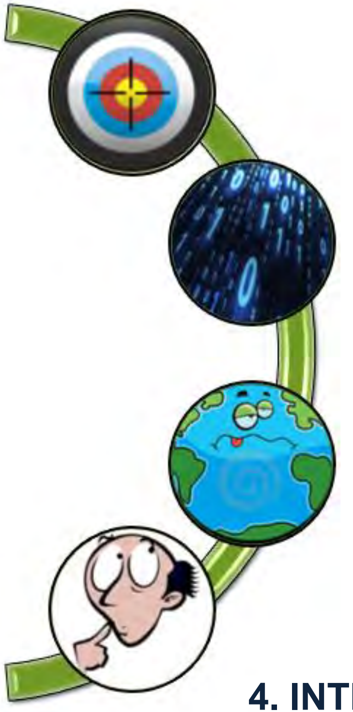
LCA of ReSiELP recovery process

SYSTEM B – Characterized impacts from the Tartaric acid treatment

	Total	Unit
GW	1.67E+03	kg CO_2 eq
PMF	2.43E+00	kg PM2.5 eq
OF	3.30E+00	kg NOx eq
TA	6.54E+00	kg SO_2 eq
FE	2.23E+00	kg P eq
ME	1.75E-01	kg N eq
HCT	1.31E+02	kg 1,4-DCB
MRS	3.16E+00	kg Cu eq
FRS	4.57E+02	kg oil eq
WD	2.00E+01	m^3



LCA analysis: Conclusions



4. INTERPRETATION

The LCA analysis shows that, overall, the process developed within the ReSiELP project is advantageous from an environmental point of view, thanks to the recovery of secondary materials. Moreover, the ReSiELP process results quite competitive in comparison with other recycling processes (especially, with the low value ones).

System A: the main benefits derive from the recovery of Al and Cu. In the Recovery line, the greatest burden is the electricity consumption while steel and cement productions are the main hotspots for the Glass reuse line; moreover, the scenario analysis showed the relevance of transportation on the environmental impact.

System B: the Tartaric acid treatment is more impacting than the NaOH treatment, due to its considerable energy consumption.

Environmental Life Cycle Costing (eLCC) analysis

Life Cycle Costing (LCC) is applied as an assessment tool to **estimate the entire cost of the system under investigation**, during its whole life cycle.

In this study the **Environmental LCC (eLCC) was performed**. It includes:

> (i) the **sum of all funds expended** in support of an item from its conception and fabrication through its operation and the end of its useful life (**internal costs**);
>
> (ii) the **external costs** of environmental impacts (also known as externalities or environmental costs).

This eLCC analysis was conducted from the **perspective** of an entrepreneur.
The **boundaries, functional units** (FUs) and **assumptions** for the studied systems (A and B) were the same as in the LCA study.

Data sources : primary and secondary data were used.

Environmental Life Cycle Costing (eLCC) analysis

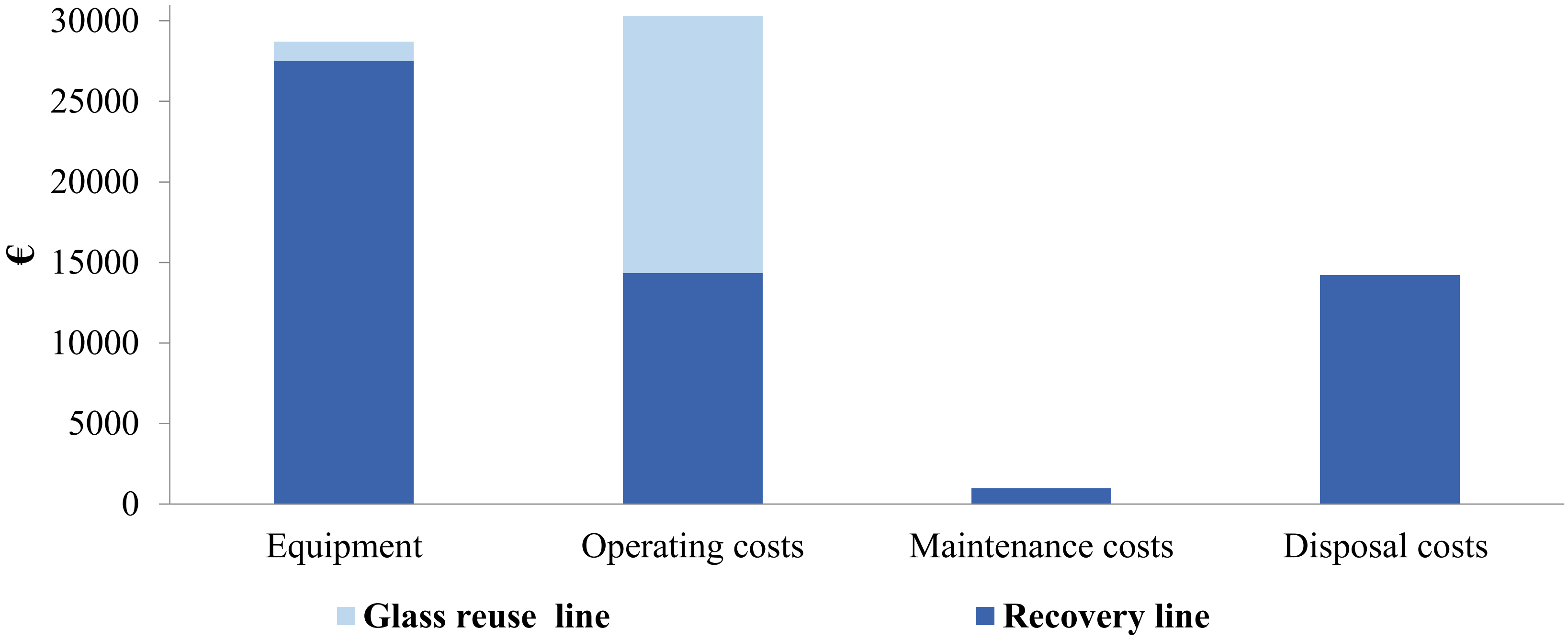
The **Environmental Priority Strategies (EPS)** approach (version 2015dx) was applied for the calculation of the externalities.

Safeguard subject/ Area of protection	Abbrev.
Abiotic Resources	AR
Access to Water	AW
Bio-Diversity	BD
Ecosystem Services	ES
Human Health	HH

The **results** of the EPS impact assessment method are **monetary values** (monetarization) of environmental impacts from emissions and use of resources. They are indicated as damage costs and are expressed as ELU (Environmental Load Units). **One ELU** represents an externality corresponding to **1 Euro** environmental damage cost.

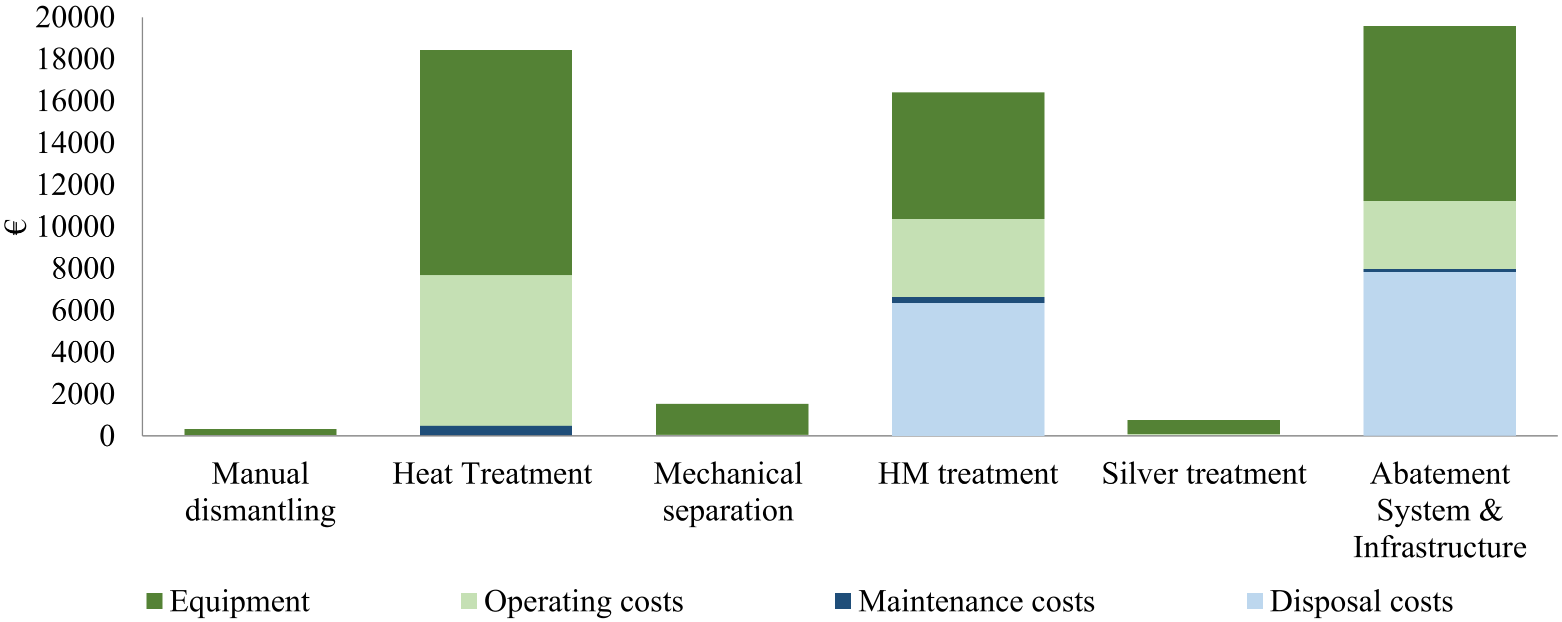
eLCC of ReSiELP recovery process

eLCC – System A (Recovery & Glass reuse lines): Internal costs



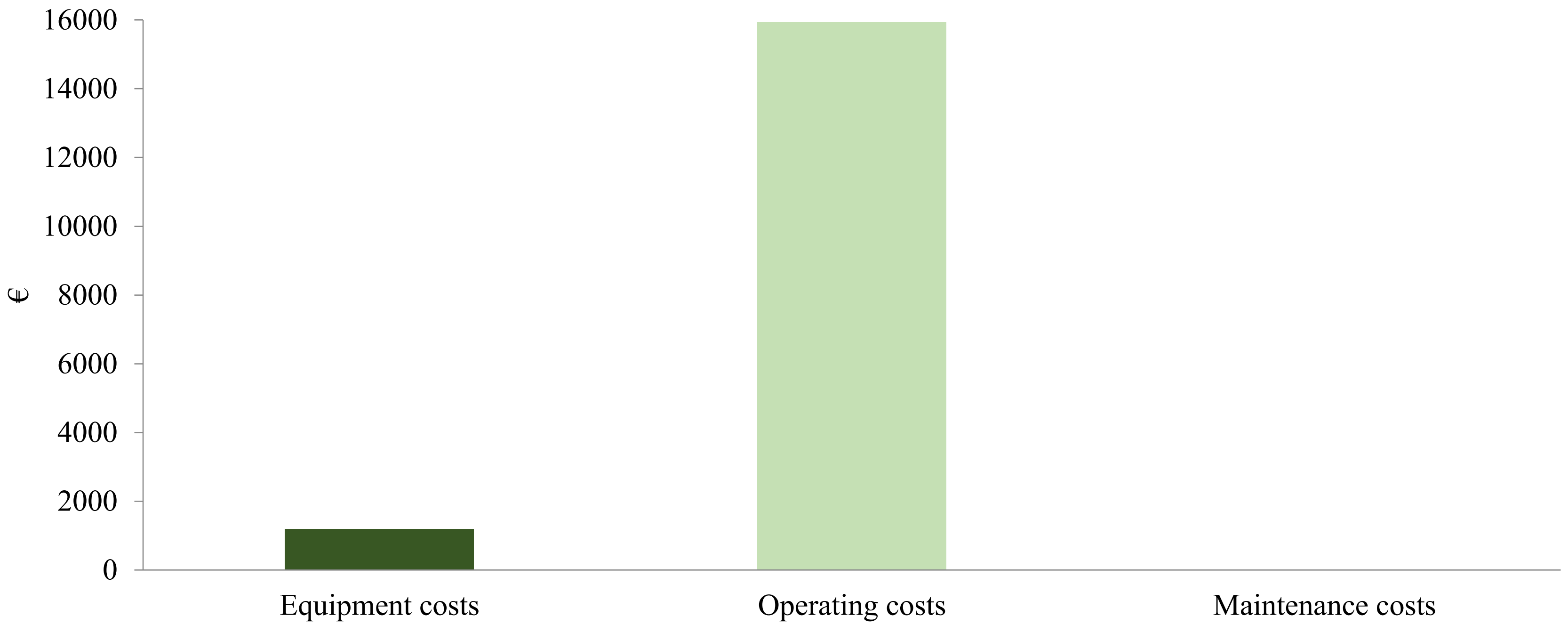
eLCC of ReSiELP recovery process

eLCC – Recovery line: Internal costs



eLCC of ReSiELP recovery process

eLCC – Glass reuse line: Internal costs



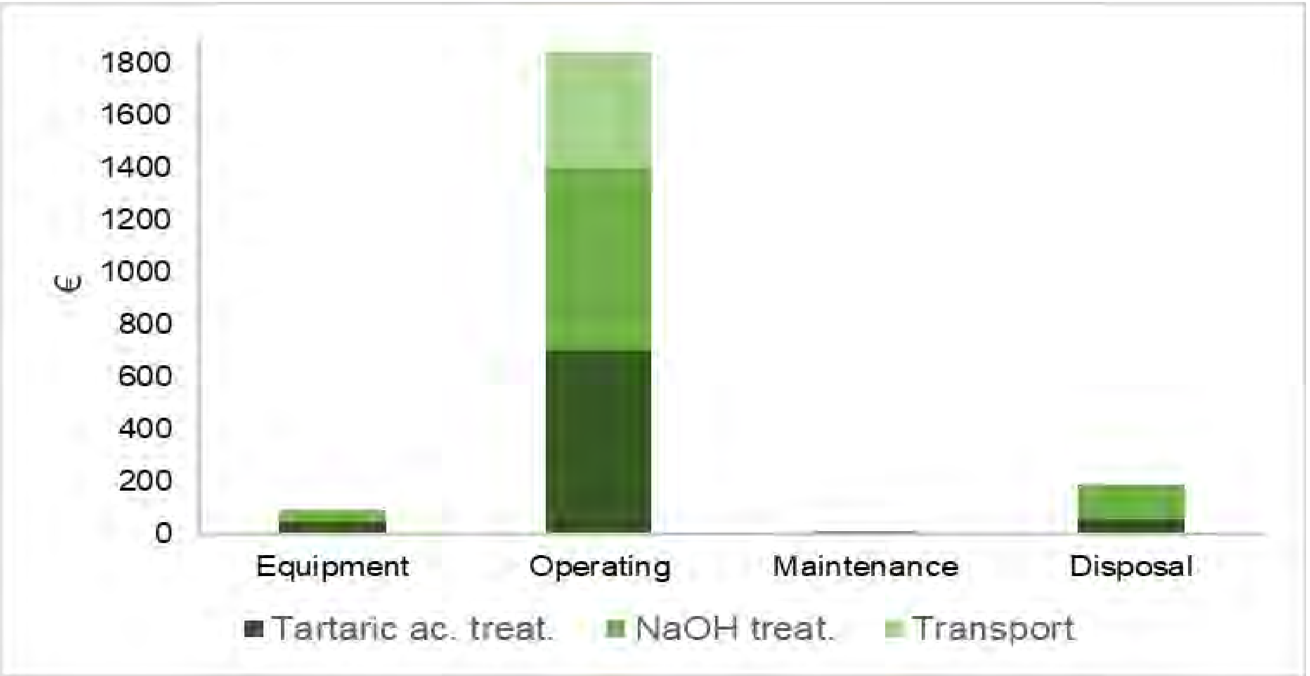
eLCC of ReSiELP recovery process

eLCC - System A (Recovery & Glass reuse lines): Externalities

Safe guard subject	Unit*	Total	Recovery line	Glass reuse line	Transport Relight ITO
Ecosystem services	ELU	-2.02E+00	-4.06E+01	-4.26E+00	4.28E+01
Access to water	ELU	4.33E-01	-1.87E+00	-2.58E-01	2.56E+00
Biodiversity	ELU	2.60E-02	-9.96E-02	-1.39E-02	1.40E-01
Human health	ELU	-1.23E+03	-2.92E+03	-1.69E+02	1.86E+03
Abiotic resources	ELU	-1.18E+05	-1.29E+05	-5.90E+02	1.12E+04
TOTAL	ELU	**-1.19E+05**	**-1.32E+05**	**-7.64E+02**	**1.31E+04**

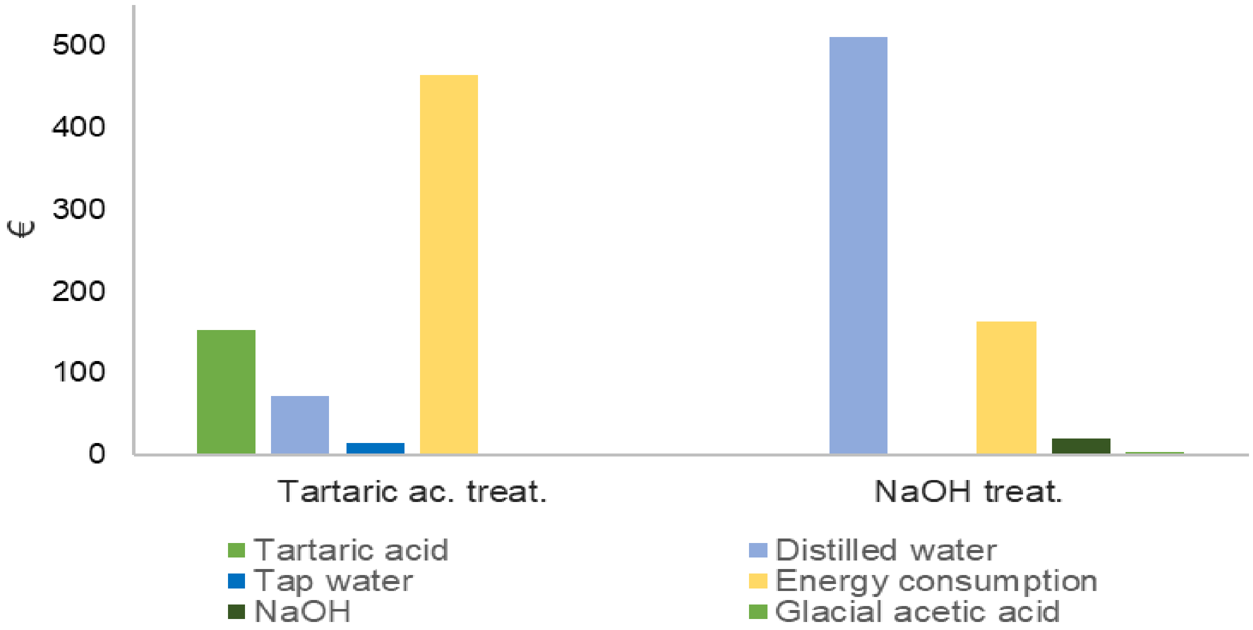
eLCC of ReSiELP recovery process

eLCC - System B: Internal costs



eLCC of ReSiELP recovery process

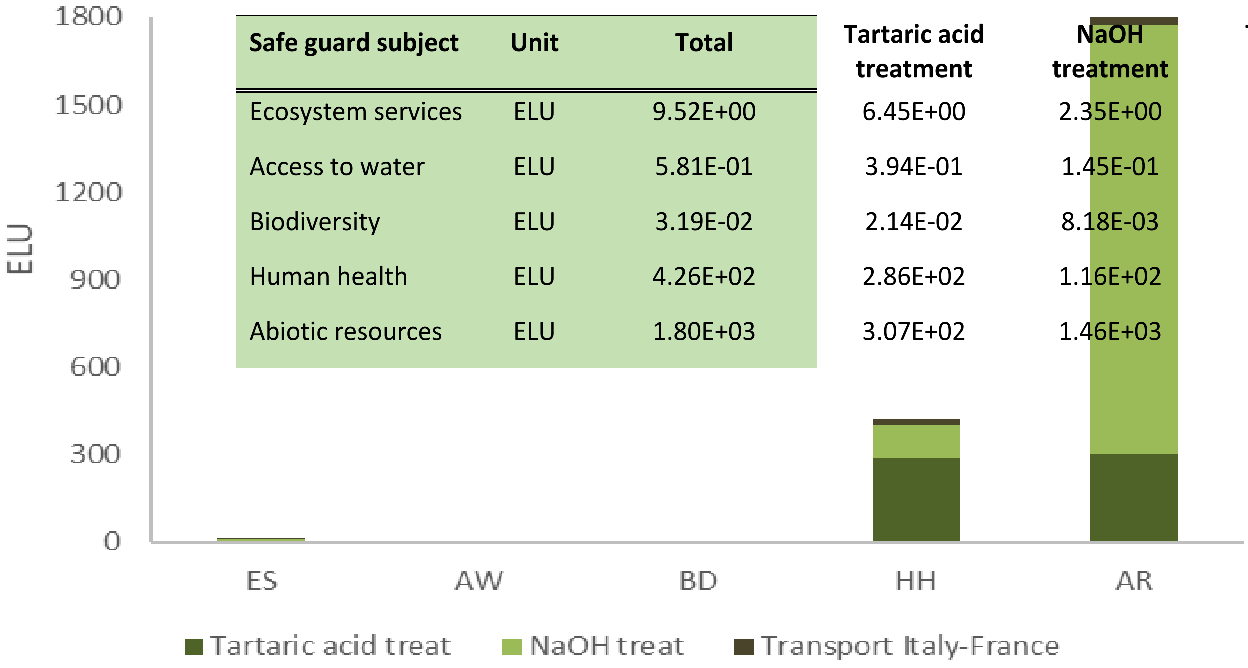
eLCC - System B: Internal costs



eLCC of ReSiELP recovery process

eLCC - System B: Externalities

The highest costs (80.5% of the total) were recorded for Abiotic Resources, followed (19.0%) by those for Human Health.

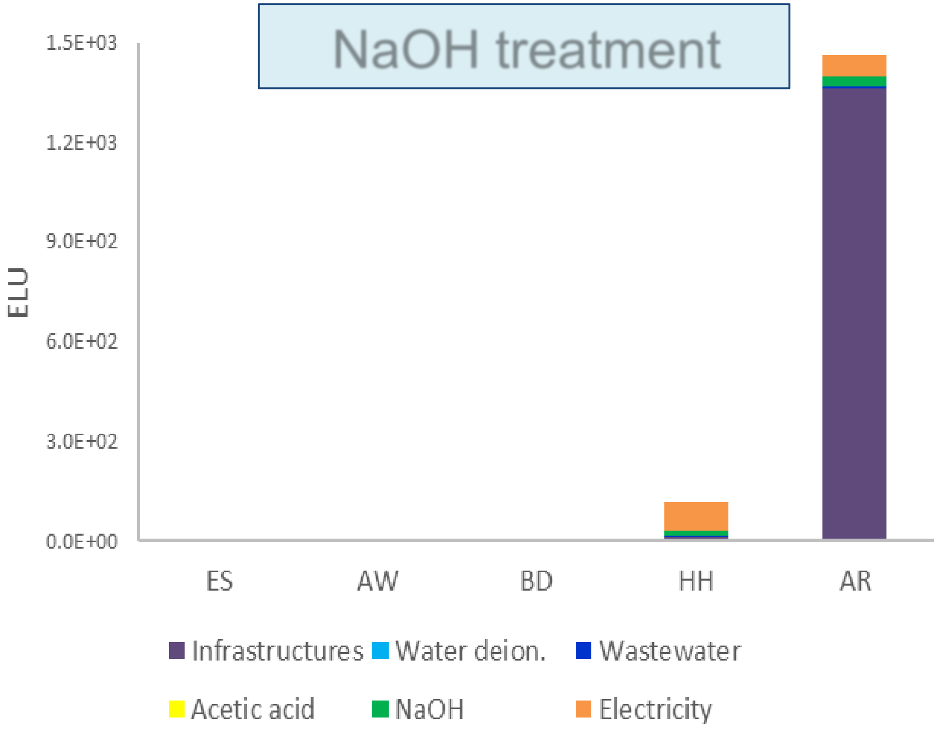


Safe guard subject	Unit	Total	Tartaric acid treatment	NaOH treatment	Tran H
Ecosystem services	ELU	9.52E+00	6.45E+00	2.35E+00	7
Access to water	ELU	5.81E-01	3.94E-01	1.45E-01	4
Biodiversity	ELU	3.19E-02	2.14E-02	8.18E-03	2
Human health	ELU	4.26E+02	2.86E+02	1.16E+02	2
Abiotic resources	ELU	1.80E+03	3.07E+02	1.46E+03	2

eLCC of ReSiELP recovery process

eLCC - System B: Externalities

The main responsible for the damage costs is the **consumption of natural resources for equipment production** (93%)



eLCC of ReSiELP recovery process

eLCC: Internal costs

- In System A, the operating phase is the most expensive, followed by the equipment costs. Recovery and Glass reuse lines contribute to an equivalent extent to the operating costs, while for all other cost categories, the main share is from the Recovery line.
- For System B, the hotspot for internal costs is the operating phase.

eLCC: Externalities

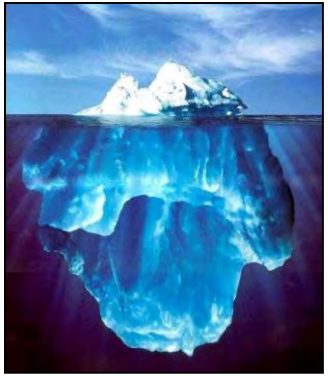
- Concerning the **externalities**, a net saving in environmental damage costs is observed thanks to the secondary materials recovery for **System A**.
- For **System B**, the highest damage costs are due to resource depletion for the production of the equipment used in the basic treatment.

Concluding Remarks

- Untreated waste and polluting emissions generate **huge impacts on human health and ecosystems**.

- Waste is not only what we see, let's keep in mind the hidden waste flows, much bigger. **Never forget the "wasteberg" !**

- Needed **investments for environmental care, landscape integrity, waste decrease and recycling, innovation** towards new materials and technologies that pollute less and provide more jobs and wellbeing.



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