LCA: Life Cycle Assessment

Workshop on openLCA

Termodinamica e Termoeconomia per le macchine.

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Definition:

"LCA is a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling."

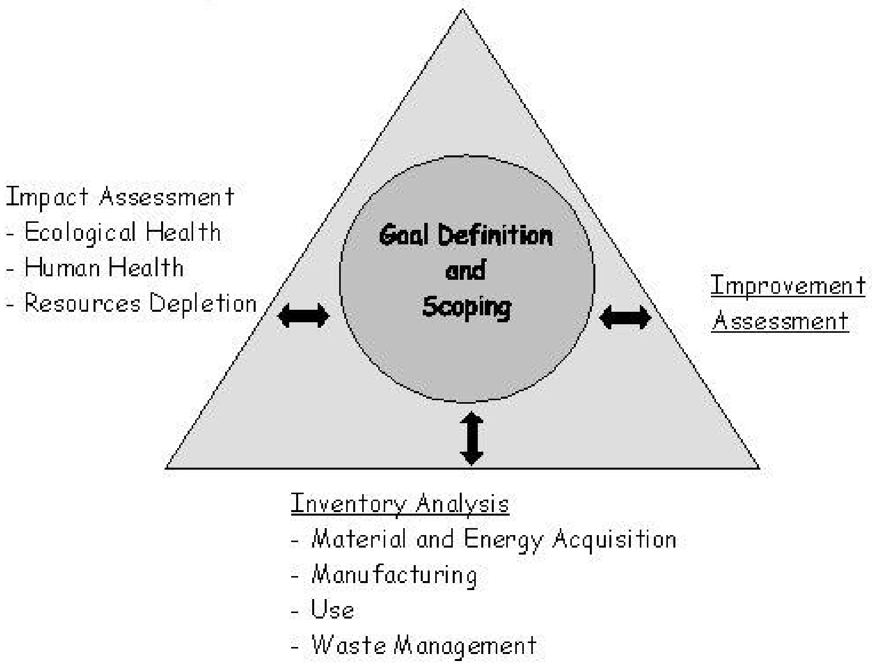
SETAC

(Society of Environmental Toxicology and Chemistry) 1993

Introduction

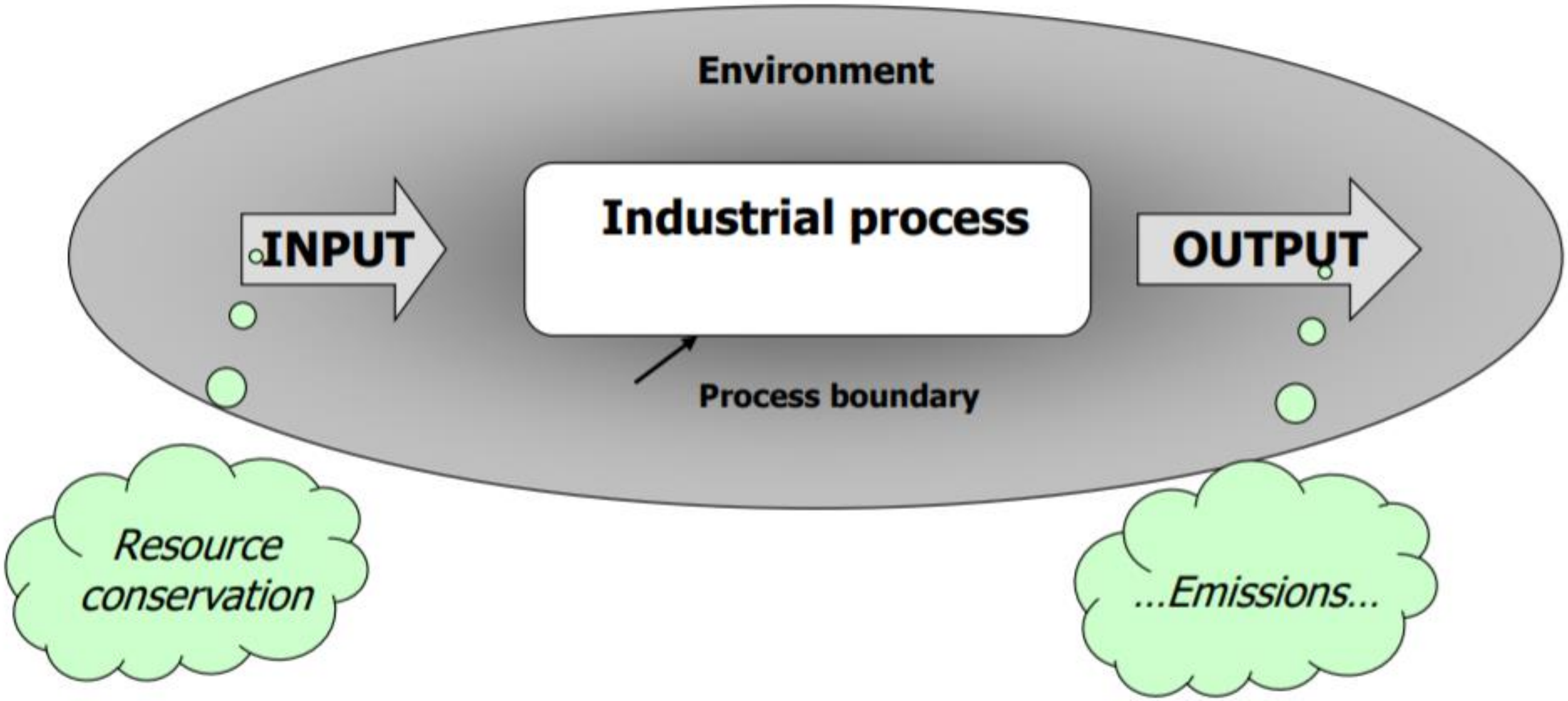
The ISO 14040 series represents an extension of the Guidelines proposed by SETAC.

- ISO 14040 (2006). Environmental management - Life cycle assessment - Principles and framework.
- ISO 14044 (2006). Environmental Management. Life Cycle Assessment. Requirements and Guidelines.



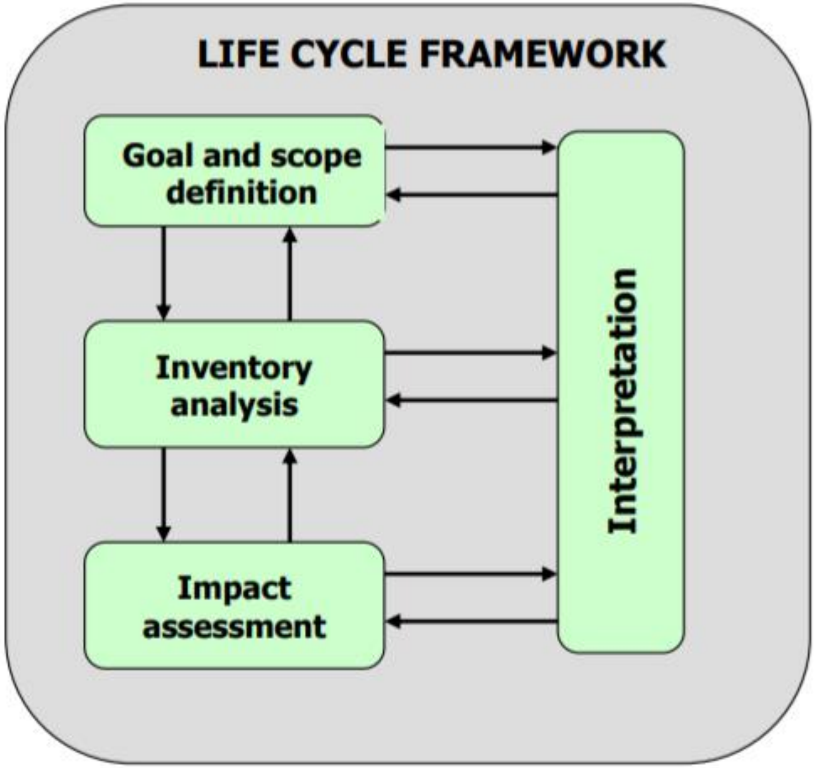
Introduction

UNI EN ISO 14040 defines LCA as "… compilation and evaluation across the whole Life Cycle of input and output flows, and of potential environmental issues, connected to a productive system….".



Introduction

The ISO 14040 standard identifies 4 steps for LCA:



- Goal and Scope Definition: the aim of the analysis is defined.
- Inventory Analysis: the inputs and outputs involved in products life cycle are defined.
- Impact Assessment: the environmental impact is evaluated attributing an impact factor to each input and output; each impact is summed to the others and is classified based on an impact assessment method.
- Interpretation: contribution analysis and possible improvements.

The 4 steps interact naturally as is common in Quality Systems. Iteration and revision of data, assumptions and boundaries are frequently necessary in LCA.

Introduction

What we need to perform a Life Cycle Assessment ?

- Software: performs the analysis.
- Database: Input and output data about the energy and material consumption and emissions of the product.
- Calculation methods: impact factors library correlating all the mass and energy flows involved in the industrial process to their environmental impact.

openLCA

http://www.openlca.org/download/

Free

Flexible

Free database

Free methods

Database:

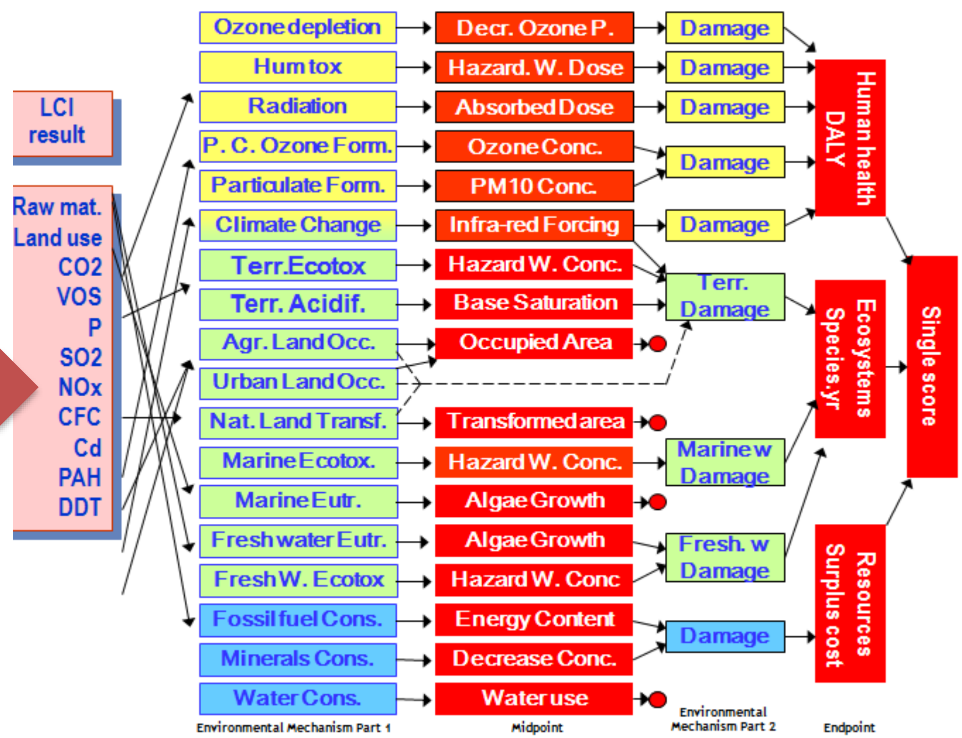
https://nexus.openlca.org/

Calculation methods :

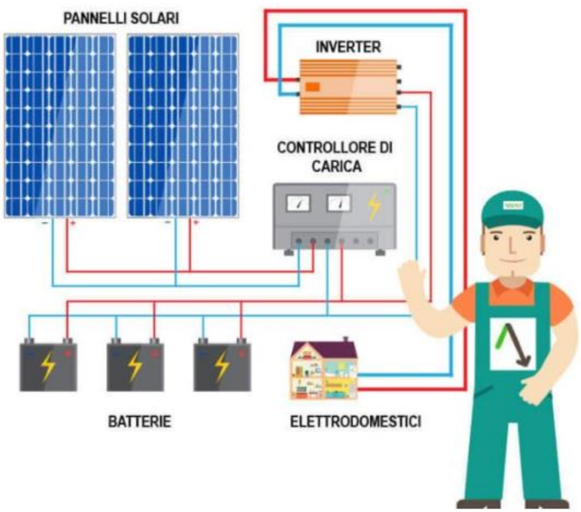
https://nexus.openlca.org/

Classification → Characterizations → Normalization → Weighting

Method	Normalisation sets
CML-IA	World 1990, 1995, 2000; EU28, 2000; EU25, 2000; West Europe, 1995; Netherlands, 1997
ILCD Midpoint	EU-27, 2010 (available soon)
IMPACT 2002+	Europe, 2000
ReCiPe	Europe, 2000; World, 2000
BEES+	USA, 1997
TRACI	US-Canada, 2008; US, 2008; Canada, 2008
USEtox	Europe, 2004; North America, 2002/2008



A photovoltaic system has been designed to provide energy to a typical residential energy consumption to make the analysis as general as possible:



Energy Consumption (E_{LOAD})= 8.75 kWh/day (Average consumption of 3 users. Terna, 2017);
System installation: Siena
Operative PV Working Hours (h_{eq}) : 2.17 h/day (PV-GIS, developed by JRC)

$t_{autonomia}$=1 d
ηel= 90%

DoD= 80%
Voltage=48 V

F=1.15

$$P = \frac{E_{LOAD}}{h_{eq} \cdot \eta el} \cdot t_{autonomia} \cdot F \ \ [W]$$

$$C = \frac{E_{LOAD} \cdot t_{autonomia}}{Dod \cdot V} \cdot F \ [Ah]$$

$P = 5.12$ [kW]

$C = 262$ [Ah]
12.5 [kWh]

	Energy from PV [MWh]	Energy to load [MWh]	Exceeding energy [MWh]	Missing energy [MWh]	Energy Losses [MWh]
Li-ion	196.256	79.815	104.246	9.759	21.954

Monocrystalline silicon

Polycrystalline silicon

Amorphous silicon

	Monocrystalline silicon	Polycrystalline silicon	Thin film amorphous silicon
Performance	15%	13%	6%
Area of 1 kWp	7.5 m2	8 m2	20 m2
Outstanding features	• Rigid panels • Sensitive to high temperature • Sensitive to shadows	• Rigid panels • Sensitive to high temperature • Sensitive to shadows	• Generally flexible • Less sensitive to high temp • Less sensitive to shadows • Lower manufacturing costs