Life Cycle Assessment and Sustainable Product Design

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Content

- Definitions
- Stages and use of Life Cycle Assessment
- Software tools, methods and databases
- Stages in Product Life Cycle
- EcoDesign strategies
- Life cycle and Ecodesign
- Concept of integrated product development
- Drivers for EcoDesign
- Integrated Product Policy
- Summarize
- Case study with Ecoscan

Definitions

- LCA is the compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system through its life cycle
  or simply is method that enables calculating the environmental impacts during the entire life cycle of a product.
- LC Cost refers to all cost associated with the system as applied to the defined LC.
- Ecodesign means that ‘the environment’ helps to define the direction of design decisions.

Stages and use of LCA

- Goal Definition. Application, Depth and System Boundaries. Set the Functional Unit.
- Inventory of Environmental Impacts. Impact table of raw material and emissions which result in different types of environmental effect.
- Classification, Characterisation and Normalisation
- Evaluation

A life cycle assessment can be used in two ways:

- 1 To determine the total environmental impact of products or design alternatives with the aim of comparing them.
- 2 To determine the most important causes of one product's environmental impact.

Applications of LCA

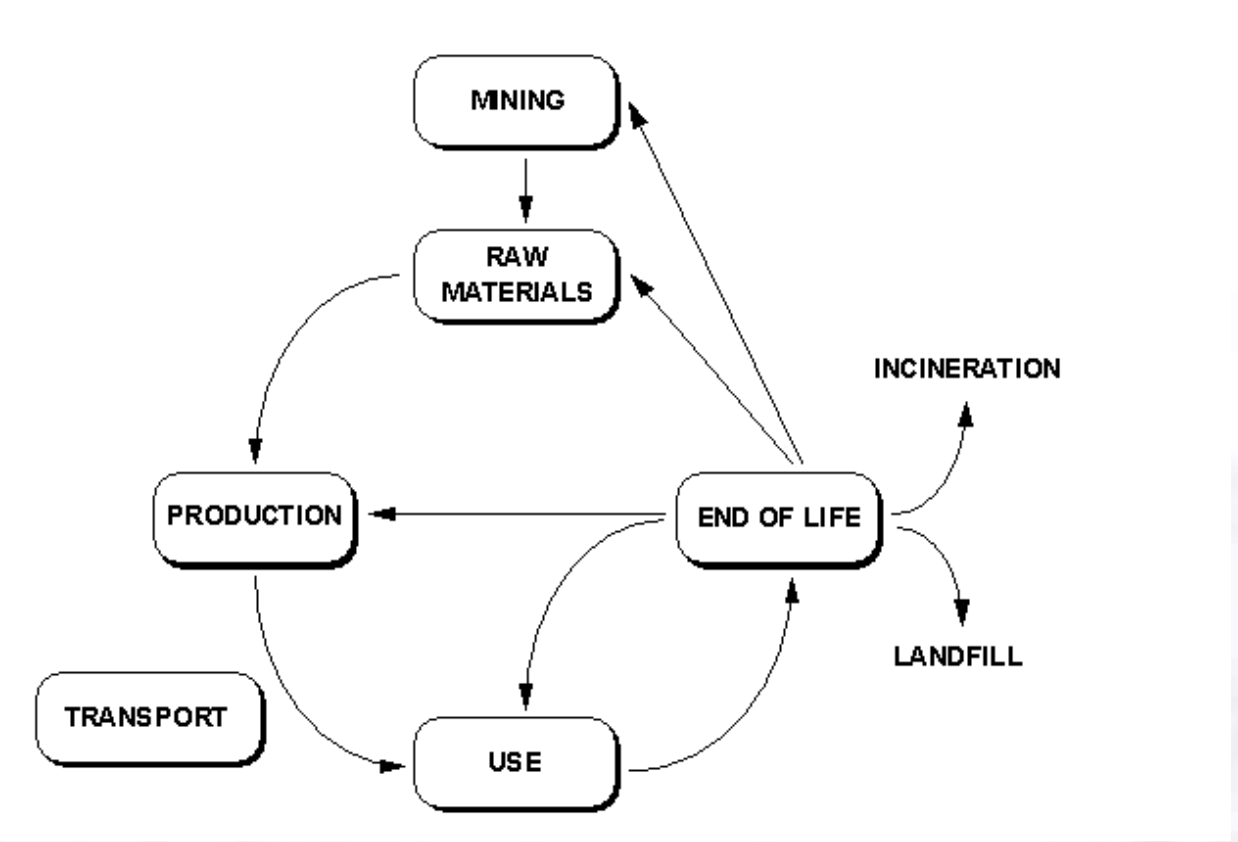
- Communicate the environmental aspects of a product
- Product and process design or/and improvement
- Develop of business strategies and investment plans
- Setting eco-labeling criteria
- Purchasing decisions
- Development of life styles

Software tools, methods and databases

- SimaPro 5
- EcoScan
- Econtrol
- EcoPro
- EPS
- Oeko-Base
- Heraklit
- Umberto
- …

- Ecopoints
- Environmental Priority System
- The Eco-Indicator
- …

Stages in Product Life Cycle



LCA of Headlamp

- Product description
  - Function: Light during darkness
  - Weight: 2.23Kg
  - 20 different components, 43 at all
  - Main material plastic
- Assumptions:
  - Functional Unit: 17 years
  - Use of lamp:1-3,5 h/day
  - Use of beams: 60W 90%, 115W 10%,
  - Bulb replace: 4 times in the time life
  - Headlamp replace: 0,5
  - Transportation: from Taiwan to Sweden
  - Disposal: Landfield

LCA of a Headlamp (cont.)

Production

Description	Amount	EI-95	Weight
Headlamp	per pc	54.29	3.23
Cover	per pc	10.17	1.01
Glass	1 pc	9.35	0.92
Rubber	1 pc	0.27	0.06
Stitch	8 pc	0.55	0.03
Case	per pc	20.86	1.86
Big Screw	1 pc	0.03	0.01
Screw	4 pc	0.09	0.02
Bulb	1 pc	1.26	0.01
Reflector	1 pc	3.51	0.33
Stitch	1 pc	0.02	0.00
Lid	1 pc	0.15	0.04
Rubber	1 pc	0.01	0.00
Screw	2 pc	0.06	0.01
Joint	1 pc	0.03	0.00
Reflector	1 pc	14.10	1.00
Screw	4 pc	0.08	0.01
Black scre	2 pc	0.03	0.01
PP	426 g	1.41	0.43
Vacuum fo	426 g	0.10	0.00
Electrical pa	per pc	23.26	0.36
Pin	5 pc	1.28	0.01
Connectio	1 pc	0.17	0.01
Wire	5 pc	21.68	0.33
Glue	1 pc	0.03	0.00
Connectio	1 pc	0.11	0.01

Use

Description	Amount	EI-95	Weight
headlamp	per pc	684.20	0.08
energy cons	1 pc	400.29	0.00
weight	1 pc	50.80	0.00
replace bulb	4 pc	5.04	0.05
headlamp	0.5 pc	228.07	0.03

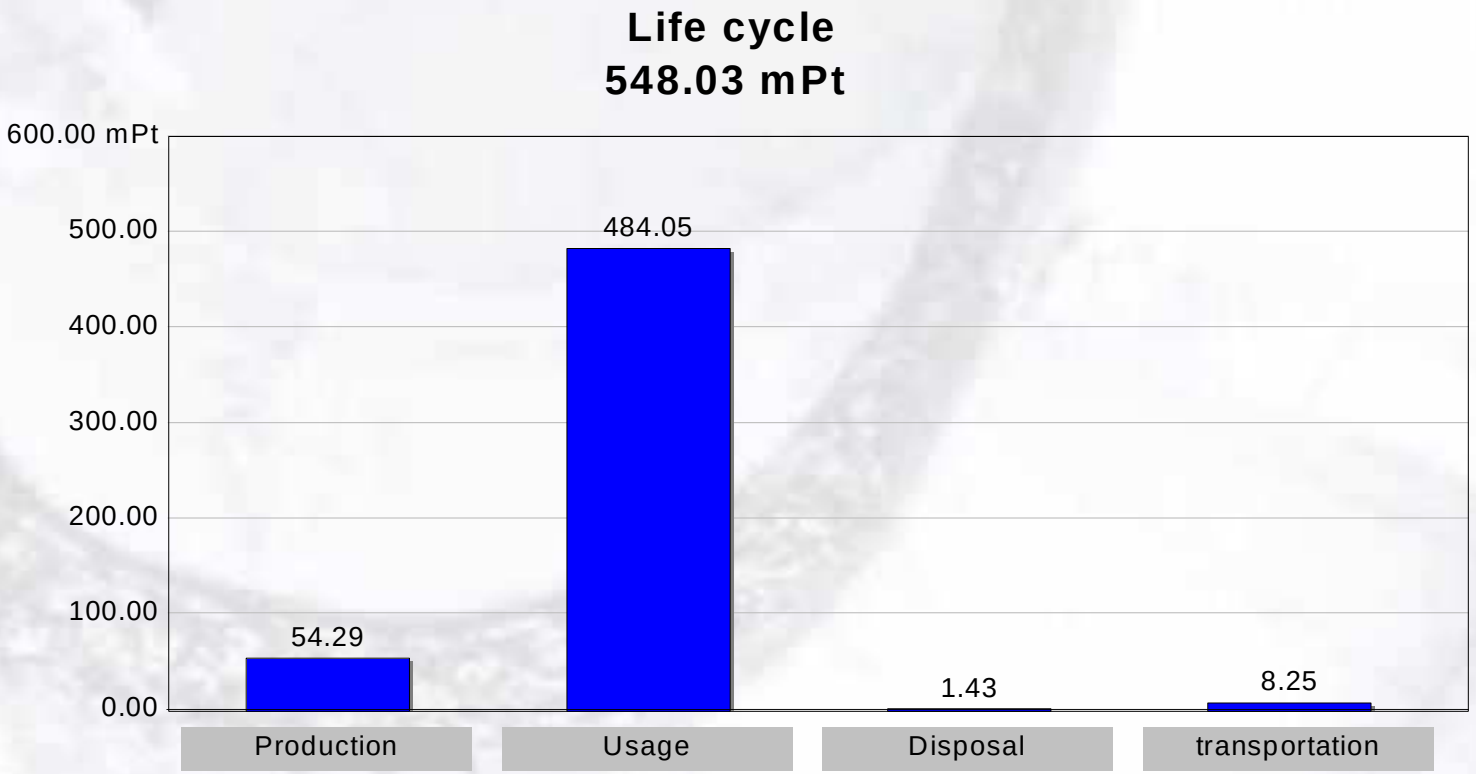
End of Life

Description	Amount	Scena	EI-95	Weight
Headlamp	per pc	Landfi	1.43	3.22
PVDC (als P	183 kg	Landfi	0.09	1.18
EPDM prod	0.1 kg	Landfi	0.00	0.10
Stainless st	038 kg	Landfi	0.03	0.04
Steel (als St	038 kg	Landfi	0.03	0.04
Glass (als G	005 kg	Landfi	0.00	0.01
Other non-fe		Landfi		
ABS (als Pla	063 kg	Landfi	0.00	0.06
PS high imp	002 kg	Landfi	0.00	0.00
PC (als Plas	1 kg	Landfi	0.04	1.00
PP (als Plas	426 kg	Landfi	0.01	0.43
Copper, prir	265 kg	Landfi	1.22	0.27
PA (als Plas	023 kg	Landfi	0.00	0.02
PVC (als PV	075 kg	Landfi	0.01	0.07

Transportation

Description	ount	EI-95	Costs	Veight
netherlan	r pc	8.25	0.00	0.00
Contair	tkm	4.13	n.a.	0.00
Truck (	tkm	0.00	n.a.	0.00
Contair	tkm	4.13	n.a.	0.00

LCA of a Headlamp (cont.)



Let’s have a brake

EcoDesign

- EcoDesign has been chosen since it implies that there is a need to balance **eco**logical and **eco**nomic requirement while developing products
- EcoDesign considers environmental aspects at all stages of the product development process, striving for products which make the lowest possible environment impact throughout the product life cycle
- Other terms are: Life cycle design, design for the environment, environmental conscious of products…

EcoDesign Strategies

1. Selection of low-impact materials
   - Cleaner products e.g. non toxic, avoid materials that deplete ozone
   - Renewable materials e.g. avoid fossil fuels, hardwood, minerals
   - Lower energy content material e.g. aluminium
   - Recycled materials e.g. paper, plastic…
   - Recyclable materials
2. Reduction of material usage
   - Reduction of weight e.g. reduce size or the construction
   - Reduction of volume in transport
3. Optimization of production techniques
   - Alternative production techniques
   - Fewer production steps
   - Lower/cleaner energy consumption
   - Less production waste

EcoDesign Strategies (continued)

4. Optimization of the distribution system
   - Less/cleaner/reusable packaging
   - Energy efficient transport mode and logistics
5. Reduction of impact during usage
   - Lower energy consumption
   - Cleaner energy sources
   - Fewer and/or cleaner consumables
   - Reduce waste of energy and consumables
6. Optimization of initial lifetime
   - Reliability and Durability
   - Easier maintance and repair
   - Modular product structure
   - Classic Design
   - Stronger product-user relation

EcoDesign Strategies (continued)

7. Optimization of end of life system
   - Reuse of Product
   - Remanufacturing/refurbishing
   - Recycling of material
   - Safer incineration

Phases of EcoDesign

- Strategy phase
- LCA and identification of the problem
- Idea generation
  - Set priorities, strategies and goals
  - EcoDesign ideas
  - Requirements: Environmental, Legal, Financial, Cost, Consumers…
- Concept design
  - Build and simulate different scenarios
  - Take decisions, chose the most favorable concept-scenario
- Detailed design and realization

EcoDesign for a Headlamp

- LCA, highest potential for improvement is at the usage phase
- Strategies
  - Focus on usage face
  - Reduction of weight/size
- EcoDesign ideas
  - End of pipe solutions
  - Technical solutions
  - Renewable energy consumption
  - Jelly lamp
  - Re-design
- Requirements:
  - Environmental: Minimization of material, energy consumption, wastes, health and safety risks during production and usage
  - Legal: Beyond compliance regulations
  - Marketing: economically feasible, marketable (attractive and suitable), price and quality
  - Consumers: Rational use, environmentally aware, new image, suitable to consumers' needs

Scenarios

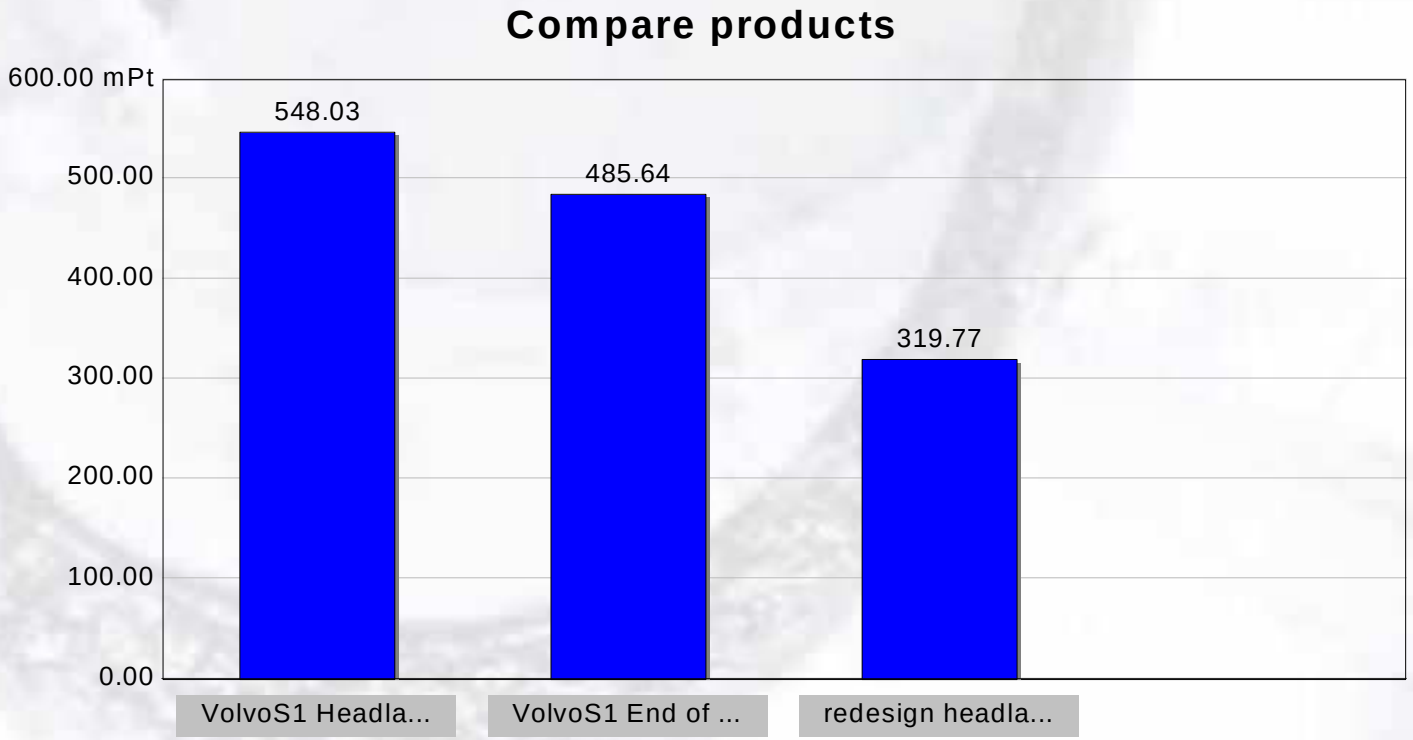
End of pipe

- Reduction of bulbs (2 instead 3)
- Change the reflector material
- Change the cover material
- Monomaterial components
- Target group: the traditional customers of Volvo

Redesign

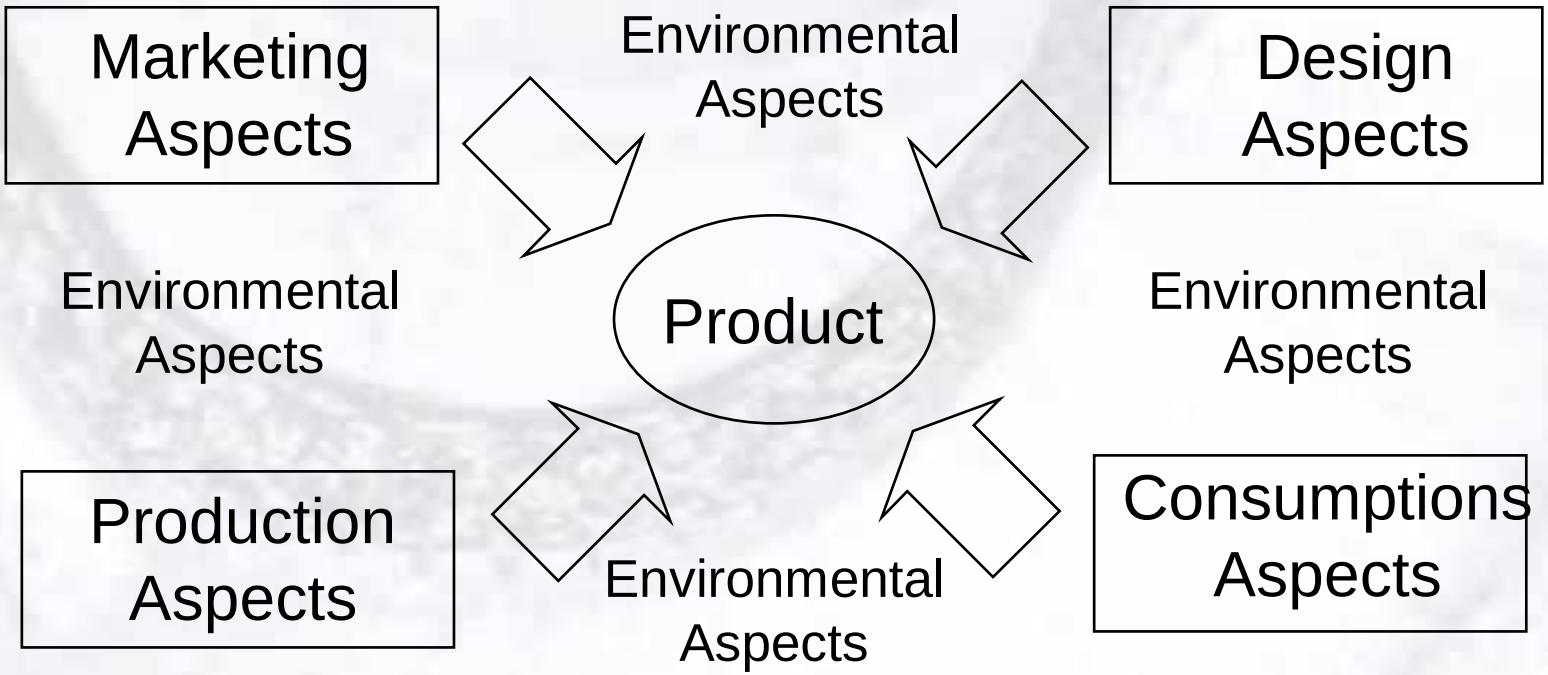
- Reduce energy consumption during the use (efficient lamp)
- Reduction of the size, weight and material
- Redesign of the front mask of the car
- Monomaterial components
- Training program for drivers
- Sensor
- Target group: move more to younger and city people

Compare the scenarios



Let’s have a brake

Concept of integrated product development



Drivers for EcoDesign

External Drivers

- Government and EU: legislation and regulations
- Market: Industrial customers and end user demands
- Competitors: leaders or followers?
- Social: responsibility towards environment

Internal Drivers

- Saving Cost
- Increase product quality
- Innovation

Integrated Product Policy

- The debate on IPP is still in its infancy. Member States of the EU are increasingly applying different environmental product policy (EPP).
- IPP is an environmental **policy toolbox** currently being discussed within the EU.
- IPP seeks to improve environmental performance of products by looking at all phases of a products' life-cycle and taking action where it is most effective.
- With so many different products and actors there can not be one simple policy measure for everything. Instead there is a whole variety of tools – both voluntary and mandatory – that can be used to achieve this objective. These include measures such as economic instruments, substance bans, voluntary agreements, environmental labelling and product design guidelines…

Summary

- LCA of products is the base of LC thinking, Ecodesign,IPP…
- EcoDesign strategies which apply in the different stages of products' LC
- At Usage stage, even the impacts are outside companies, there is the highest potential of improvement
- …

Goal of the case study

- Not to be become experts in LCA and ecoscan
- Introduce you in LC Thinking
- You may never use LCA in your professional life but will hear often about it and you will use more LC Thinking
- The core of the exercise will be to identify environmental impacts, Interpretate results of LCA and design sustainable products based on your analysis

Guidelines for EcoDesign

1. Describe the product and the functional unit.
2. Present the product tree and LCA graphic (4 stages)
3. Interpretate LCA results
4. Set priorities for improvements

Guidelines for EcoDesign (cont.)

5. Decide for appropriate EcoDesign strategy/strategies.
6. Present brainstorming results for a new product concepts and improvements.
7. Present requirements in relation to LC strategies (function, material, structure, Legal, consumers behavior, marketing, …)
8. Decide if you will develop one scenario (product) or more and explain the drivers of your decision.

Guidelines for EcoDesign (cont.)

9. Present the new design concept(s).
   a. Describe product, present assumptions and functional unit
   b. Product tree (copy from ecoscan)
   c. Show drawings if necessary
   d. Give key marketing issues
   e. Give estimations of technical and economical feasibility
10. Compare existing product with the new concept(s)
11. Beyond LC Design and product

Presentation

- Duration: about 20 minutes
- Assessment criteria:
  - Language
  - Style
  - Adequate use of methods
  - Structure of the presentation
  - LCA of existing product
  - Interpretation and brainstorming
  - New concept presentation
  - Innovation
  - Interdisciplinary view
- Be inspired, innovative and have fun doing so!