CIRAIG

Interuniversity Reference Center for the life cycle Assessment, Interpretation and Management of products, processes and services

The Econo-Environmental Return (EER)

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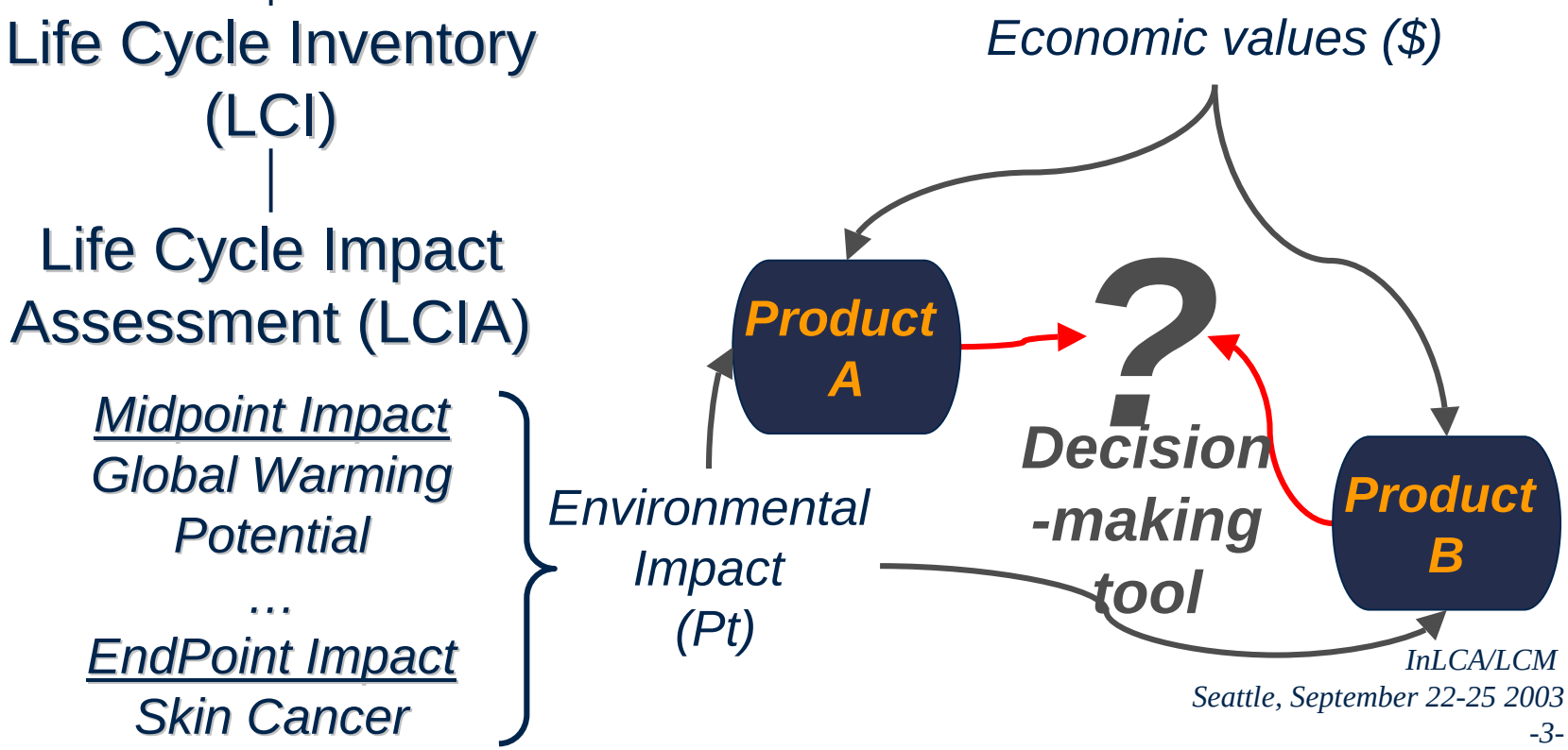
Outline

- Introduction
- Current models
- Problem with using the selling price
- New approach linked to economic sciences
- Application example

Comparison Problem

Life Cycle Management (LCM)

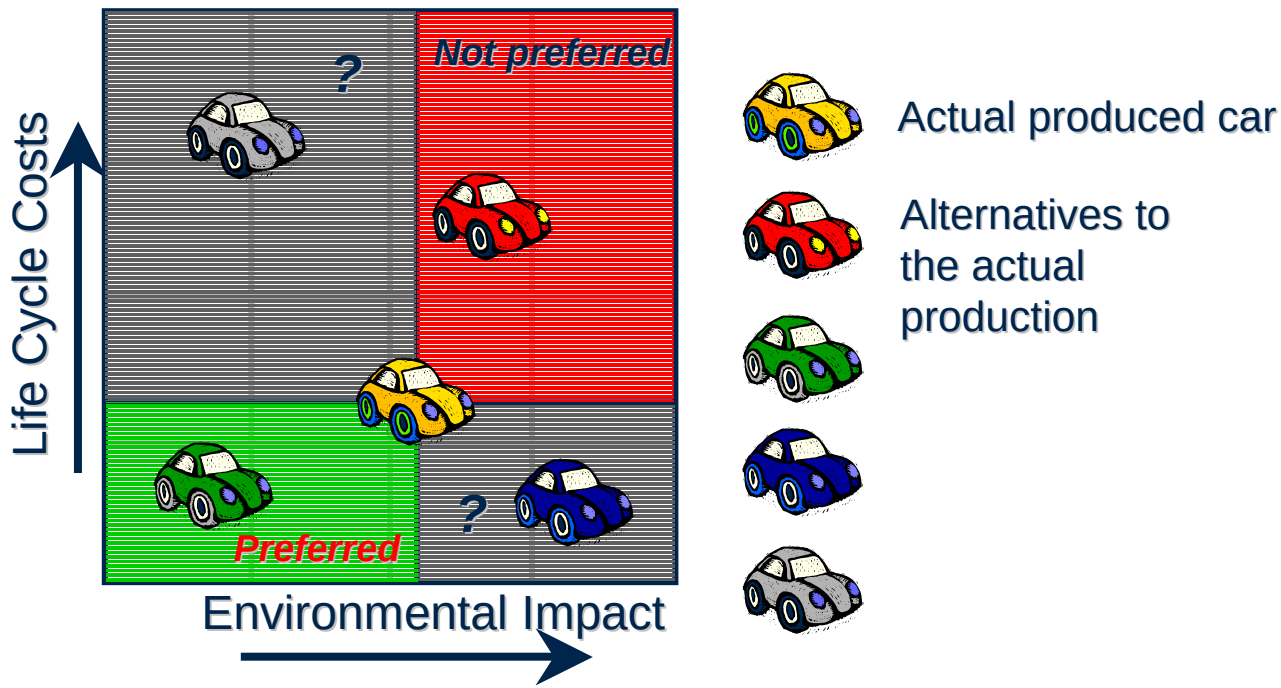
- Life Cycle Assessment (LCA)
  - Life Cycle Inventory (LCI)
    - Life Cycle Impact Assessment (LCIA)
      - *Midpoint Impact*
        Global Warming Potential
        …
      - *EndPoint Impact*
        Skin Cancer
- Life Cycle Costing (LCC)



Decision-Making Objectives

Introduction

Primary objective: Select the alternative which optimizes both environmental and economic considerations

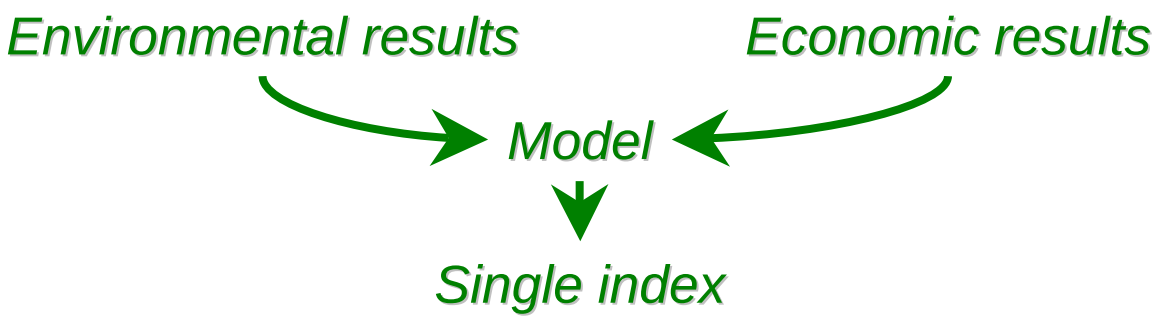


Combination Tool

Introduction

- Too often
  - Product A is preferred from an environmental point of view
  - Product B is preferred from an economic point of view
  - *Which product should be chosen in such a context?*

Secondary objective: Find the best compromise between environmental and economic considerations



Selection of the alternative comparing each alternative's single index

Return On the Environment (ROE)

Current models

(Hunkeler and Biswas 2000)

Develop statistically acceptable ROE values for different activity sectors

Each new product would be compared to the ROE value of its activity sector

$$ROE = \frac{\text{Life Cycle Cost/Selling Price}}{\text{Scaled Impact Assessment}} \cdot 100\%$$

Selling Price: Follows LCC increase

Provides an adimentional and normalized economic value

ROE is therefore not a product-specific tool

Green Productivity Index

Current models

(Kim and Hur 2002)

Compare the level of green productivity of several similar products or services

Productivity: Production of an economic value resulting from an investment

Green Productivity: Production of an economic value respecting the environment

$$\text{P Index} = \text{Selling Price/Life Cycle Cost}$$

$$\text{GP Index} = \frac{\text{Selling Price/Life Cycle Cost}}{\text{Environmental Impact}}$$

Eco-Efficiency

Current models

(Okada *et al.* 2002)

Compare different types of lamps (silica light bulb, tungsten halogen lamp, fluorescent lamp, …) using both environmental and economic considerations

Only Global Warming Potential (CO_2 from electricity production) and Hg emissions (from some types of lamps) are considered in the model development

$$\text{Eco - Efficiency} = \frac{1/\text{Global Warming}}{\text{Cost}} \text{ x } \frac{1/\text{Emission Hg}}{\text{Cost}}$$

Selling Prince

+

Electricity production costs

Problem with Using the Selling Price

General case: Production and consumption take place in a no-free-market

- Each producer or salesman has enough power to affect the market in his favour
- Imperfect competition

As a result: Selling price can artificially affect these combining tools

Example of the market penetration

Selling price ↘

$$\text{GP Index} = \frac{\text{Selling Price/Life Cycle Cost}}{\text{Environmental Impact}} \quad \searrow$$

$$\text{ROE} = \frac{\text{Life Cycle Cost/Selling Price}}{\text{Scaled Impact Assessment}} \cdot 100\% \quad \nearrow$$

But no change in

- *Environmental impact*
- *Total costs*

New Approach

Based on the Return on the Investment

$$\frac{\text{Annual Costs}}{\text{Annual Benefits}} = \frac{(1+i)^n - 1}{i \cdot (1+i)^n}$$

Temporal consideration

Economy: Distinction between present and future economic values

Environment: No distinction between present and future environmental impact (n=1)

$$\frac{\text{Annual Costs}}{\text{Annual Benefits}} = \frac{(1+i) - 1}{i \cdot (1+i)}$$

New Approach

Based on the Return on the Investment

$$\frac{\text{Impacts}^{-}}{\text{Impacts}^{+}} \cdot \frac{\text{Costs}}{\text{Benefits}} = \frac{(1+i)-1}{i \cdot (1+i)}$$

$$\frac{\text{EnvI}^{-}}{\text{EnvI}^{+}} \cdot \frac{\text{EconI}^{-}}{\text{EconI}^{+}} = \frac{1}{1+\text{EER}}$$

Econo-Environmental Return

New approach

$$EER = \frac{EnvI^{+} \cdot EconI^{+} - EnvI^{-} \cdot EconI^{-}}{EnvI^{-} \cdot EconI^{-}}$$

Model advantages:

- Requires 4 data inputs which can be generated using any methodology
- Allows the use of data which has been discounted or not
- Can evolve with LCA and LCC modifications in future

Model disadvantages:

Need for a relative comparison tool

- No reference value for comparison since the interest rate for the ROI, EER alone as no signification
- Due to result aggregation, often both positive and negative data are not available
  - $EconI^{+}$ can be included in $EconI^{-}$
  - $EnvI^{+}$ can be included in $EnvI^{-}$

Relative Econo-Environmental Return

New approach

Comparing alternatives when data are aggregated (Example):

Alternative A - Alternative B

1. Set one alternative as the reference one
2. <u>For this alternative</u>: Change unknown data to known data (respecting data types)
3. <u>For the other alternatives</u>: Change unknown data to similar data of the reference alternative
4. Evaluate the Relative EER for each alternative

Alternative A: Reference

$EconI_A^+ = EconI_A^-$

$EnvI_A^+ = EnvI_A^-$

$EconI_B^+ = EconI_A^+ = EconI_A^-$

$EnvI_B^+ = EnvI_A^+ = EnvI_A^-$

$$EER_{A/A} = 0$$

$$EER_{B/A} = \frac{EnvI_A^- \cdot EconI_A^-}{EnvI_B^- \cdot EconI_B^-} - 1$$

Application Example

Site remediation technologies

- **Bioventilation *in situ***
  - Env. Impact Neg.: 2 864.5 Pt
  - Env. Impact Pos.: 3 259.1 Pt
  - Costs: 1 616 723$
  - Benefits: 1 461 259$
- **Biopile**
  - Env. Impacts Neg.: 3 259.1 Pt
  - Env. Impacts Pos.: 3 259.1 Pt
  - Costs: 1 616 723$
  - Benefits: 1 616 723$

Bioventing
Preferred alternative from both an economic and environmental point of view

3

Env. preferred

Reference 1

2

Econ. preferred

$EER_{Bp/Bp} = 0\%$

$EER_{Bv/Bp} = 2.8\%$

4

Conclusion

- Producers have to
  - Respect internal as external environmental criteria
  - Be profitable
- Need for a decision-making tool combining both environmental and economic consideration
- **EER and Relative EER**
  - Allow the comparison of products or services
  - Require data (discounted or not) that can be generated with several methods
  - Can evolve with possible future modifications in both LCA and LCC methodology
  - Are not based on the assumption of free market

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