



Life Cycle Assessment for Ecodesign: a Two-Edged Sword

Raw materials for the future:
from black to green gold?

FFC

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Sylvain CAILLOL



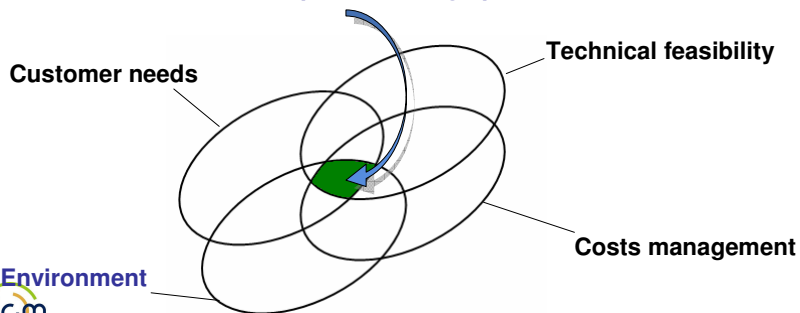
What is ecodesign ?

Ecodesign :

Take into account environmental issues in products and processes design.

It is a preventive approach, in order to lower future environmental impacts from early steps of the process.

Integration of environmental impacts in design process



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Outline

- Taking into account environmental issues: design under constraints
- How to realize ecodesign – Life Cycle Assessment
- LCA: a powerful tool for innovation, to be used correctly

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Constraints



- *Non renewable resources are decreasing*
- *Prices are increasing*

⇒ *Need for renewable resources*

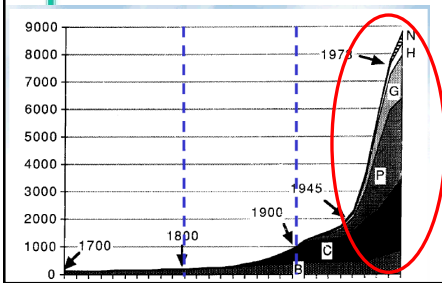


- *CO₂ emissions are increasing*

⇒ *Objectives for reduction*



- *Wastes volumes are increasing*



- *Global energy consumption is increasing*

⇒ *World consumption in 2006 : 10.8 Gtoe*

Last 50 years
Energy consumption x 4
Population x 2

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2000 : 6 billions humans
3 billions leaving in towns

2050 : 9 billions humans
6 billions leaving in towns



Sources : UNESCO

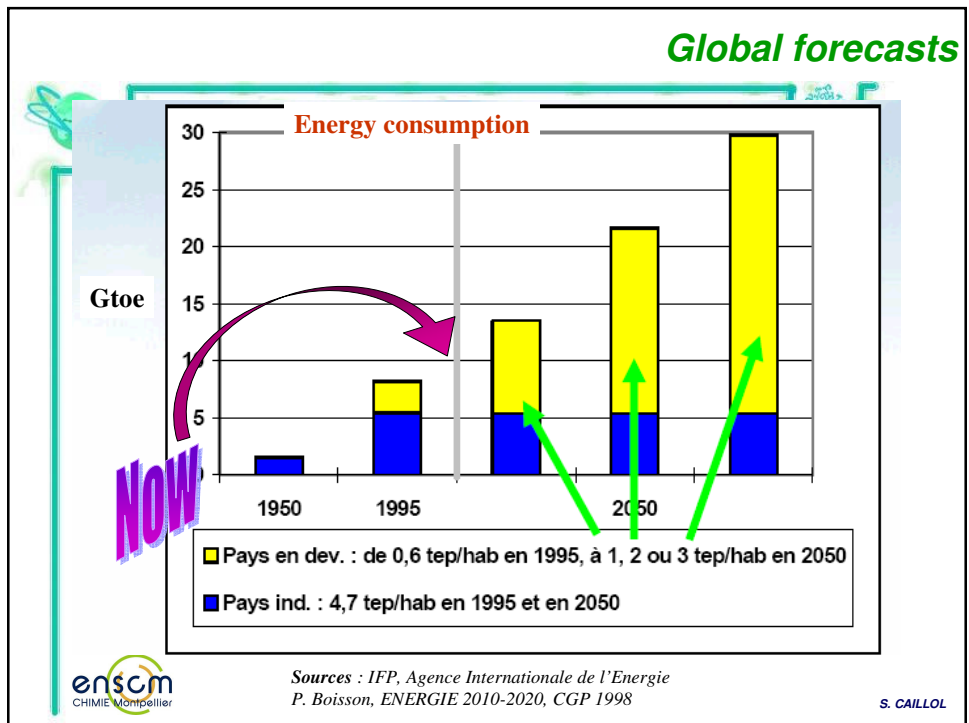
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**2000 : 6 billions humans
3 billions leaving in towns**

**2050 : 9 billions humans
6 billions leaving in towns**

Twice as many towns ?

Sources : UNESCO
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How to perform ecodesign

In the design of products and services, we are under constraints, forced to take into account environmental issues, forced to ecodesign...

In order to « Ecodesing » a product or a service,
We are facing environmental questions...

To gain 50 t
emission
license of
CO₂...

Which material is the « greenest »
?

Aluminum

Cotton

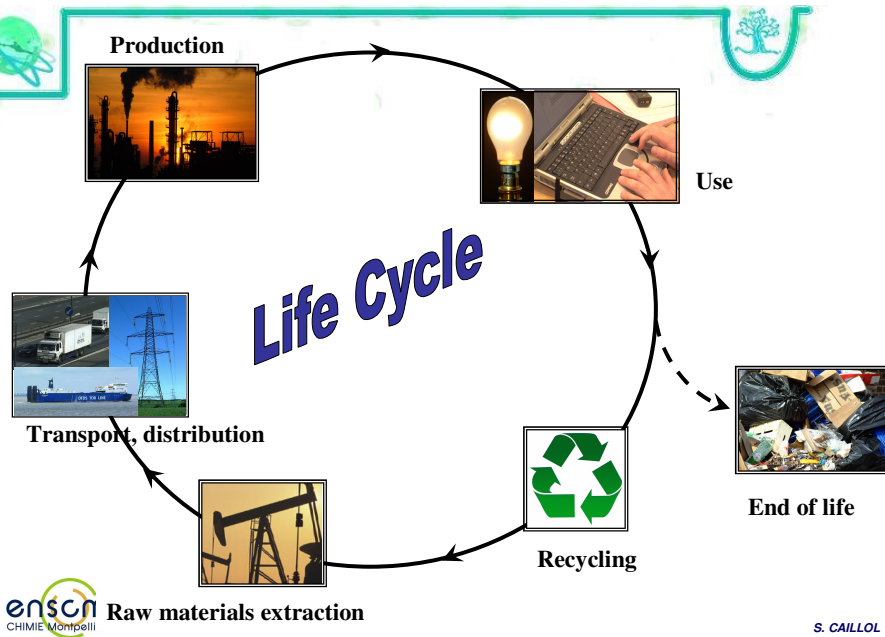
Plastic

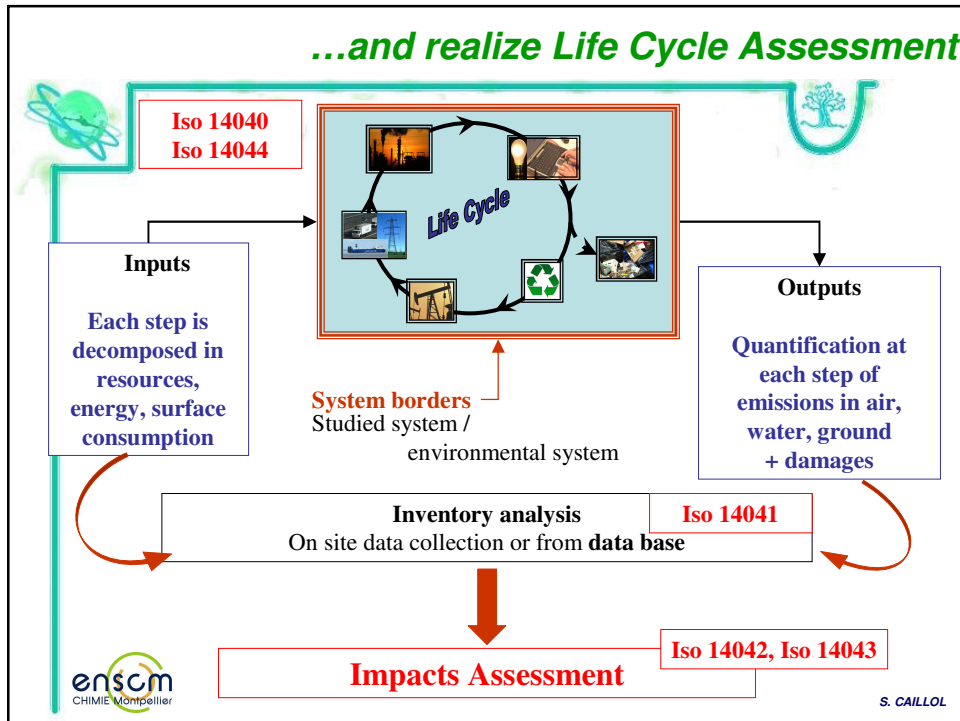
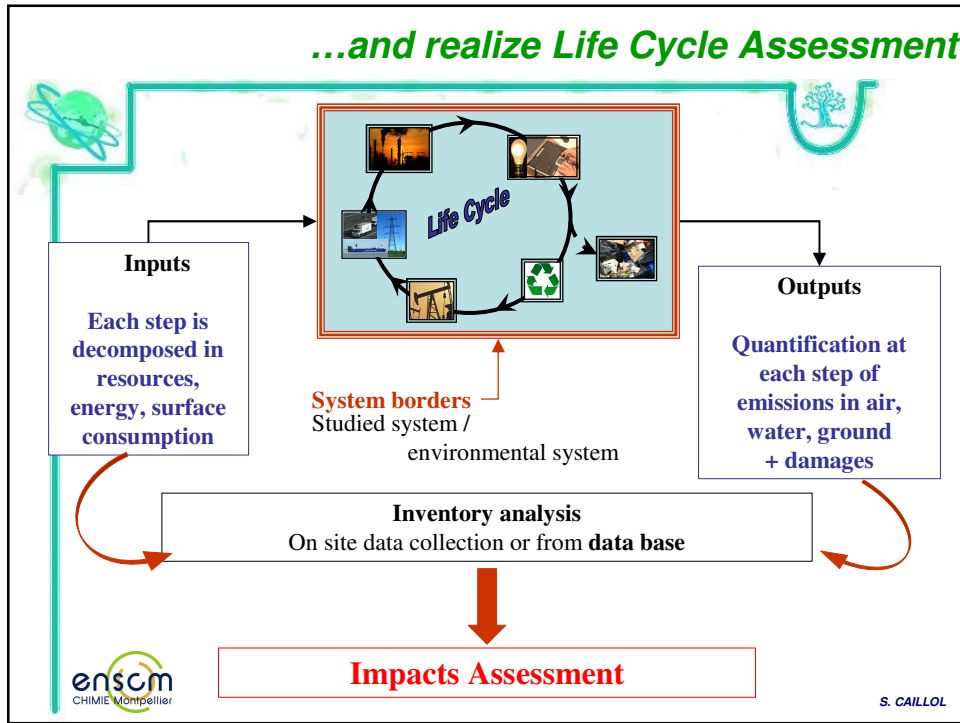
Concrete

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- LCA: a powerful tool for innovation, to be used correctly

To answer, we'd better take into account...





Impacts assessment

Class	Type	Geographic scale
Exhaustion of natural resources	<ul style="list-style-type: none"> • Renewable R • Non renewable R 	Global or regional
Green house effect		Global
Ozone layer depletion		
Toxicity and ecotoxicity	<ul style="list-style-type: none"> • Toxicity • Acidifica • Eutroph 	
Degradations	<ul style="list-style-type: none"> • Noise • Smell • Visual 	
Physical degradation of ecosystems	<ul style="list-style-type: none"> • Desertification • Deforestation • Biodiversity 	Local or regional Local or regional Regional or global

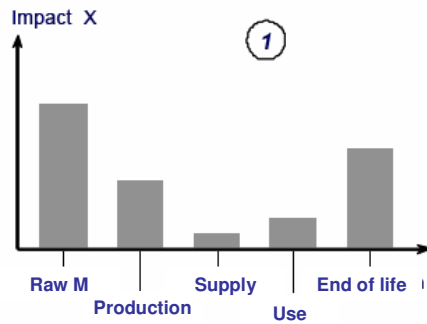
No hierarchy of impacts !!!

Outline

- **Taking into account environmental issues: design under constraints**
- **How to realize ecodesign – Life Cycle Assessment**
- **LCA: a powerful tool for innovation, to be used correctly**

Why LCA ?

To identify main environmental impacts sources
To choose between two (or more) systems: for example fossil and biobased

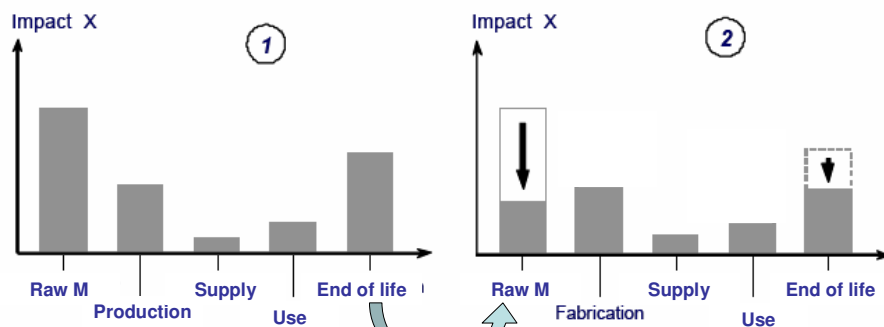


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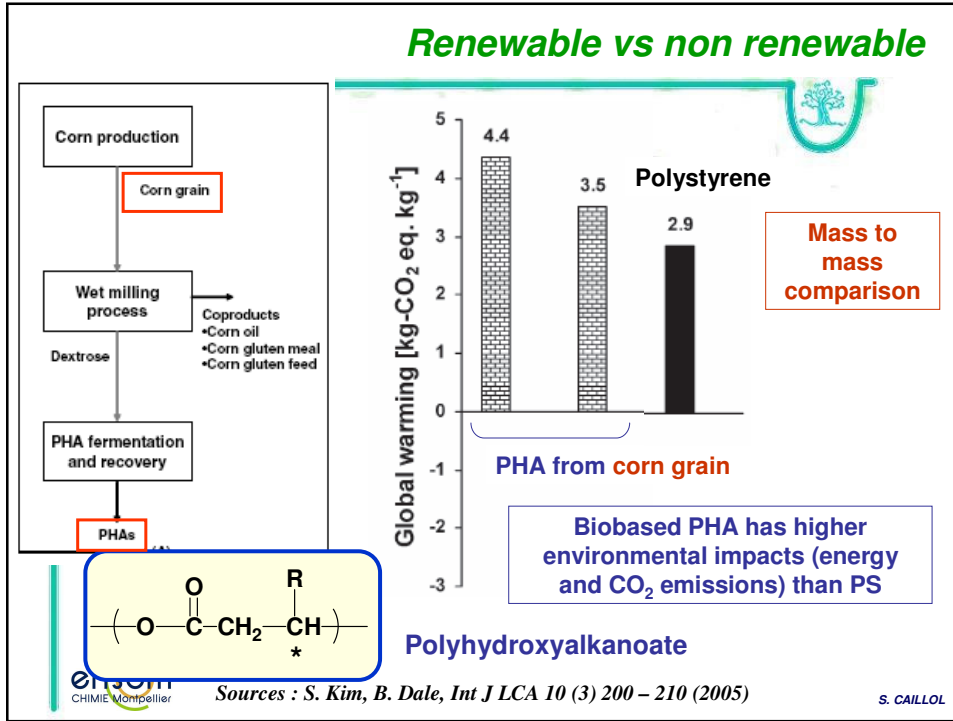
Innovation is created in looking for best solutions

LCA: a powerful tool for decision

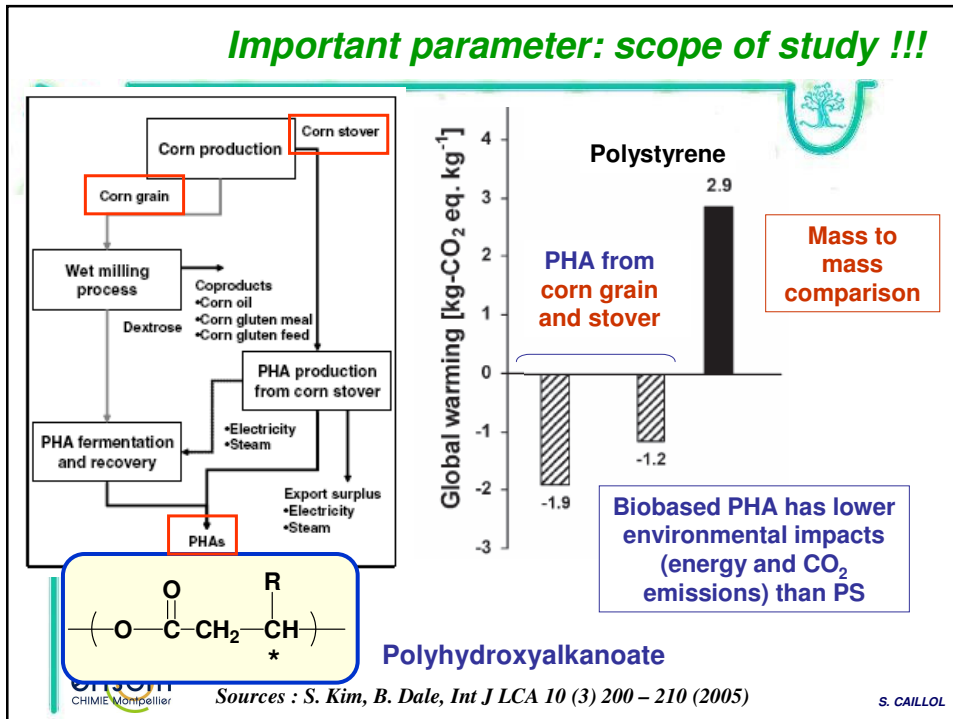
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Renewable vs non renewable



Important parameter: scope of study !!!



Packaging chips LCA

> **Functional unit (FU) : packed volume**
The service and not the mass of material



ADEME



Packaging chips	From Starch	From polystyrene
Functional Unit		100m ³
Farming surface (ha-year/FU)	0.18	-
Non renewable energy consumption (GJ/FU)	28	39
Non renewable energy consumption (GJ/ha-year)	155	216

$$\text{Relative gain (\%)} = \frac{\text{Impacts (fossil - renewable)}}{\text{Substituted fossil}} = \frac{(39-28)}{39} = 28\%$$

Starch: lower impacts !!

Sources : G. HOUILLON, BG IC,
 O. JOLLIET, J. KAENZIG, EPFL

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LCA study of shopping bags Carrefour

Identification, quantification and comparison of environmental impacts of 4 different shopping bags from Carrefour:

- “Single use” polyethylene HDPE bag - 14L – non renewable
- “Reusable” polyethylene LDPE bag - 37L – non renewable
- “Single use” paper bag - 20L – based on renewable resources
- “Biodegradable” plastic bag - 25L – based on renewable resources

Functional unit:

“to pack 9000L of goods in shops of the Group”

We do not compare one bag to another...but a service



ECOBILAN

Hypotheses 9000L :

= 45 visits per year in shops, 200L products by visit (80% cart)

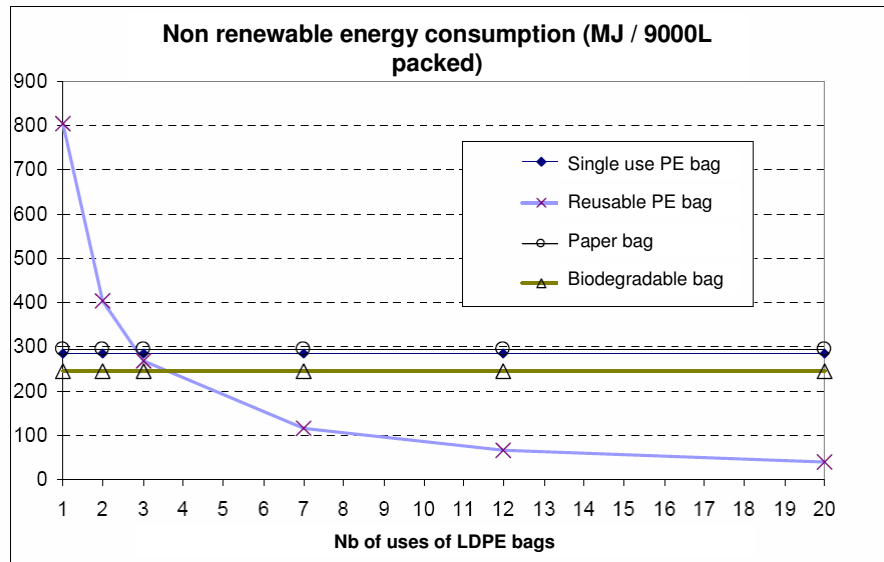
→ Nb of each type of bag / 9000L → Quantity of material

→ LDPE bag reusable until 20 times...



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Non renewable energy consumption



Results : best bag is LDPE bag

Raw materials production step has highest environmental impacts for all bags and all impacts

↳ **Results are improved by a reduction of the mass of the bags or by reusing the bag**

Transports: low impacts

Bags manufacturing: impacts lower than material production step

Above a certain number of reuse, for this study, the best compromise is the LDPE reusable bag

Next step :

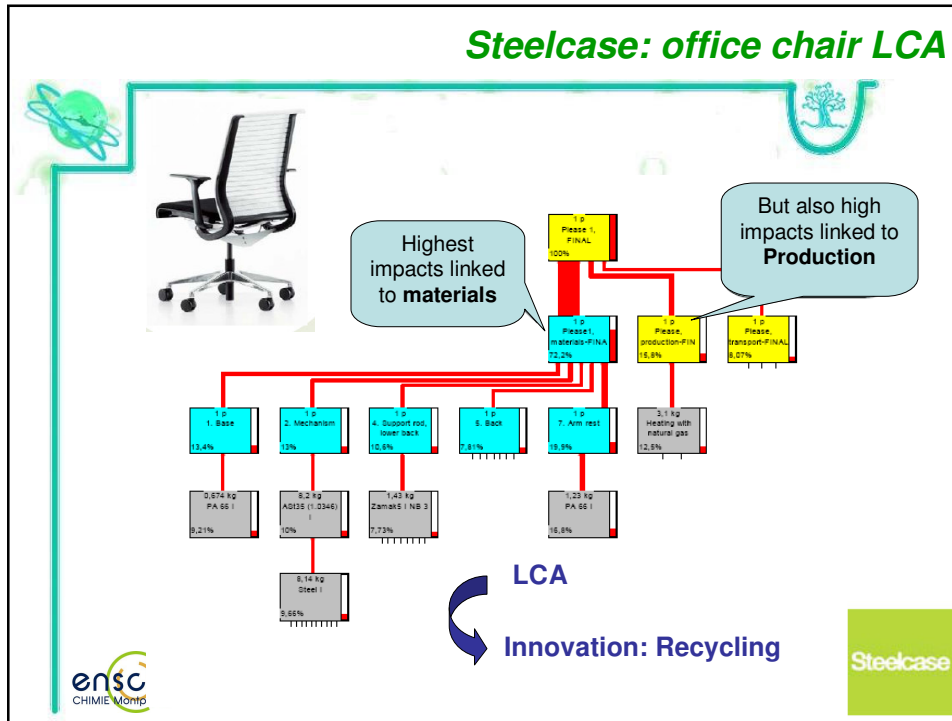
Avoided processes?

Hypotheses ?

Comparison of reusable bags of same mass and study of reuse of biodegradable or renewable resourced bags?

Shopping bags reused as garbage bags was not taken into account, therefore we could add this process...

Steelcase: office chair LCA



Reduction of raw material impact: recycling



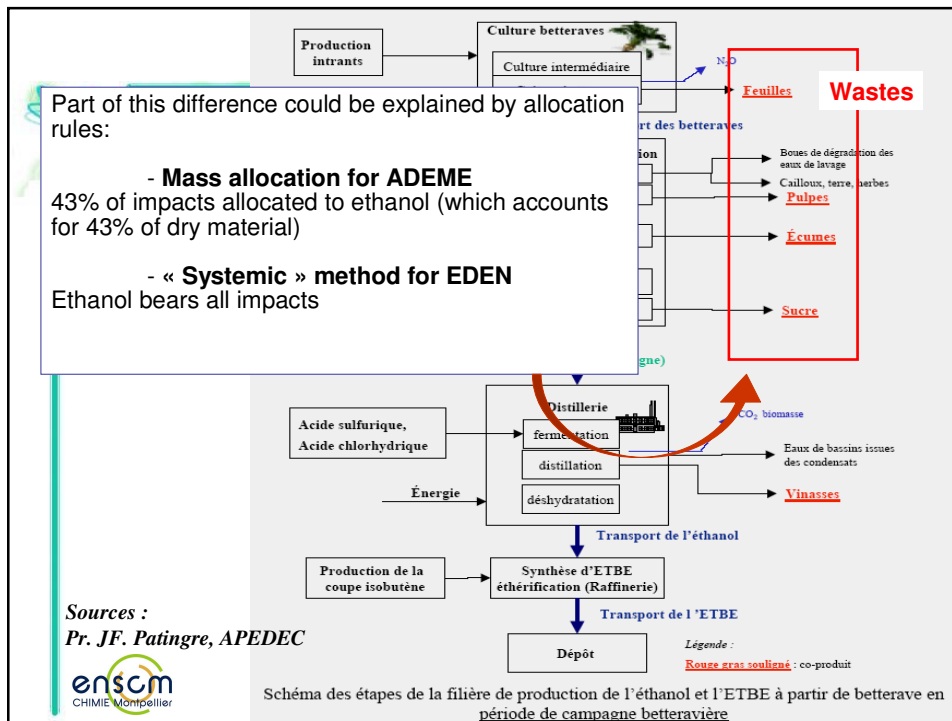
Important parameter: allocation rules

Compared LCA of biofuels: Bioethanol and ETBE

Bioethanol : Ethanol from agrosources (beetroot, sugar cane, wheat...)

Etbe : Ethyl Tertio Butyl Ether – produced from reaction between ethanol and isobutene (47% of bioethanol and 53 % isobutene)

Energetic yields yielded energy / non renewable energy used		
	EDEN 2006	ADEME 2002
Wheat ethanol	1,1	2,05
Beetroot ethanol	1,19	2,05
Wheat ETBE	1,1	1,02
Beetroot ETBE	1,03	1,02



End of life: "avoided" processes by recycling

Ex : comparison of recycling and burning with energy collection for paper

System 1: valuation of paper by recycling



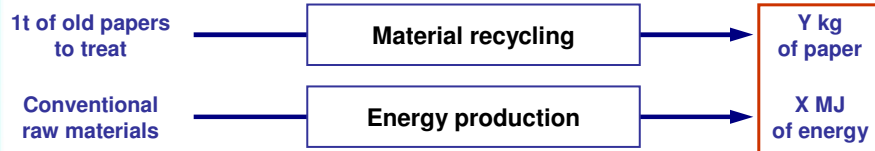
System 2: energetic valuation of paper



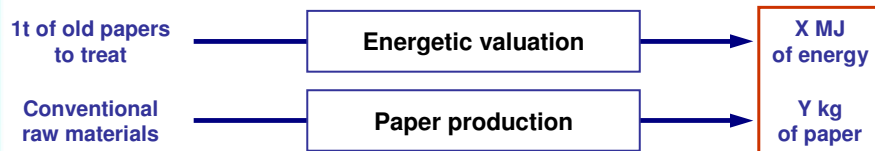
Comparison of these systems non possible since service is not the same !!!

End of life: "avoided" processes by recycling

System 1 modified: valuation of paper by recycling and energy production



System 2: energetic valuation of paper and paper production



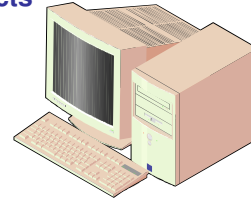
Comparison possible !!!

Scope of study definition

- Desktop PC → higher impacts
- Screen: > 50% of impacts
- Laptop PC ≈ 40% of desktop PC impacts



But...



Borders, Hypotheses ?

- Battery of laptop PC was not taken into account
- Life time fixed to 5 years – but in reality: life time of laptop PC is shorter (handling, transport...)
- Easier replacement of components for a desktop PC → longer life time and reuse
- Cathodic screen for desktop PC / LCD screen for laptop PC



Sources: Analyse du cycle de vie

O. Jolliet, m. Saadé, p. Crettaz

Collection gérer l'environnement (Presses Polytechniques et universitaires romandes, 2005)

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Advantages and limits of LCA

- **Analysis on the whole life cycle, with all parameters**
Not an analysis on a single effect (raw materials, GEG, carbon footprint...)

⇒ **Allows to really compare fossil and renewable resources**

- **Allows to guide innovation**
- **Standardization with Iso 14040**
- **Very different results** owing to hypothesis, FU, scope of study...
- **Comparative analysis (no absolute):** elements vary owing to situations, geographic areas, hypothesis and scope of study, and vary also with time...not systematic up-to-date
- Inventory step may be costly and long and could entail non consistent results or lead to giving up the analysis

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“Easy” LCA

➤ Simplified method in order to guide decisional progresses in early steps of projects

➤ FFC

Dematerialization

➤ Replacement of product by a service

➤ Management of end of life products in order to keep on service delivery

➤ Recycling showed to be an important way of lowering environmental impacts

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