
Life Cycle Assessment: a key decision tool for biomass valorization

CHEMICAL ENGINEERING

Processes and Sustainable Development

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1. **Context of research**
 2. Life Cycle Assessment methodology
 3. Environmental evaluation of biomass utilization
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-



Context

- Environmental consciousness of politics, industrials and consumers
- “20/20/20” European goal
- 13% of renewable energy in Belgium in 2020



Context

- Belgian renewable energy availability
 - Wind
 - Solar
 - Hydroelectricity
 - Biomass
- Support tools for politics decisions
 - Need of “sustainable” tools



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Life Cycle Assessment – Methodology

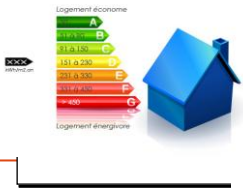
- LCA = Life Cycle Assessment
 - Environmental Management tool
 - Standardized tool (Standards ISO 14040 – 14044)
 - Still in development (methodology – methods – context)



Life Cycle Assessment – Definition

- “ LCA describes environmental aspects and potential impacts throughout a product’s life cycle, i.e. raw material acquisition, production, use and disposal” ISO 14040
- Product = material product or service
- “Cradle to grave” approach


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Life Cycle Assessment – Uses

Internal	<p>Strategy</p> <ul style="list-style-type: none"> Potential impacts of products on environment Investments decision support 	<p>R & D products/process</p> <ul style="list-style-type: none"> Early identification of problems/opportunities Assistance in projects selection Assistance in defining objectives
	External	<p>Marketing</p> 




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Life Cycle Assessment – Steps

- Four stages described in ISO 14040



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graph TD; A[Goal and Scope definition] <--> B[Inventory analysis]; B <--> C[Impact assessment (LCIA)]; A <--> D[Interpretation]; B <--> D; C <--> D; D <--> E[Direct applications];
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The diagram illustrates the four stages of Life Cycle Assessment (LCA) as defined in ISO 14040. It consists of five orange rounded rectangular boxes. On the left, three boxes are stacked vertically: 'Goal and Scope definition', 'Inventory analysis', and 'Impact assessment (LCIA)'. These three boxes are interconnected by double-headed vertical arrows. To the right of this stack is a larger vertical box labeled 'Interpretation'. Double-headed horizontal arrows connect 'Goal and Scope definition', 'Inventory analysis', and 'Impact assessment (LCIA)' to 'Interpretation'. To the right of the 'Interpretation' box is another box labeled 'Direct applications', connected to it by a double-headed horizontal arrow. The entire process is contained within a white rectangular frame.

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Biomass utilization


- Belgian biomass
 - Organic waste
 - Wood
 - Used as pellets, chips by individuals or industries
 - Energy crops
 - “First generation”
 - Rapeseed
 - Wheat
 - Sugar beet
 - “Second generation”
 - Still in technological development






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Biomass utilization


- Sugar beet
 - Transformation in bioethanol via fermentation of sugars



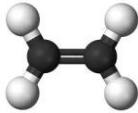





- → Proved fuel potential
- → Chemical potential as bioethylene?




Best sustainable choice ?






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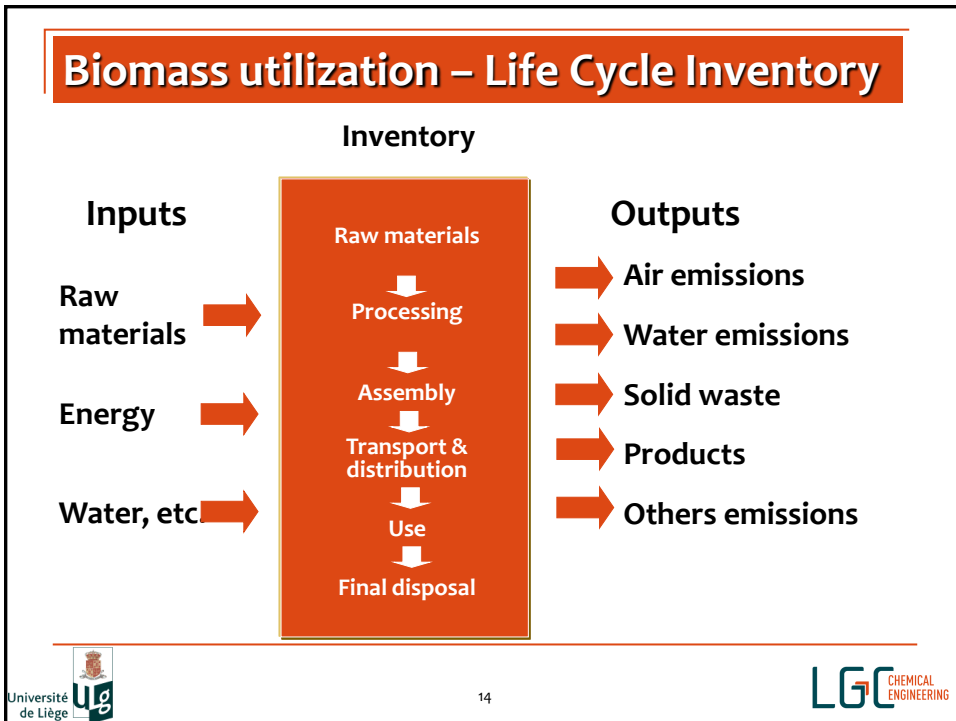


Biomass utilization – LCA

- Goals of study
 - To compare production of ethylene from bioethanol or from fossil fuels: ‘bioethylene’ vs. ethylene
 - To allow debate on the use of bioethanol
- Functional unit
 - Bioethylene production from the cultivation of one ha of arable land




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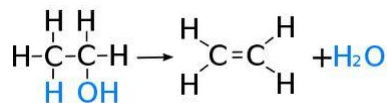


Biomass utilization – Life Cycle Inventory

- Steps for bioethanol production
 - Cultivation of one ha
 - Production of seeds, fertilizers production, cultivation, harvest, etc.
 - Transportation
 - From agricultural land to factory
 - Production of bioethanol
 - Fermentation, pasteurization, distillation, drying of byproducts, etc.

Biomass utilization – Life Cycle Inventory

- Steps for bioethylene production
 - Bioethanol production
 - All steps described before
 - Dehydration of bioethanol into bioethylene



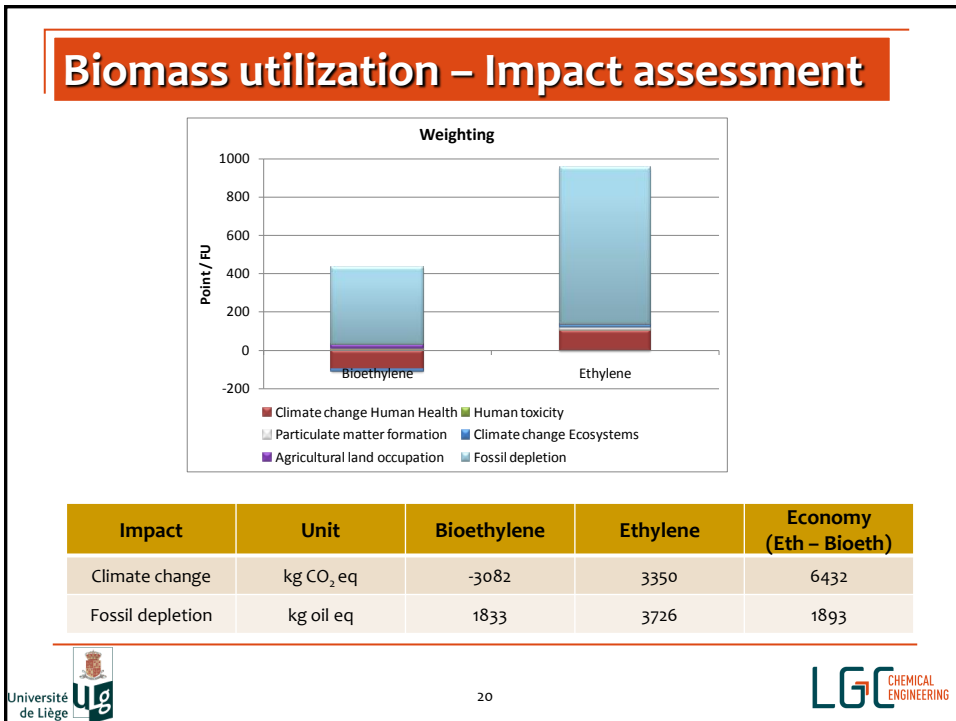
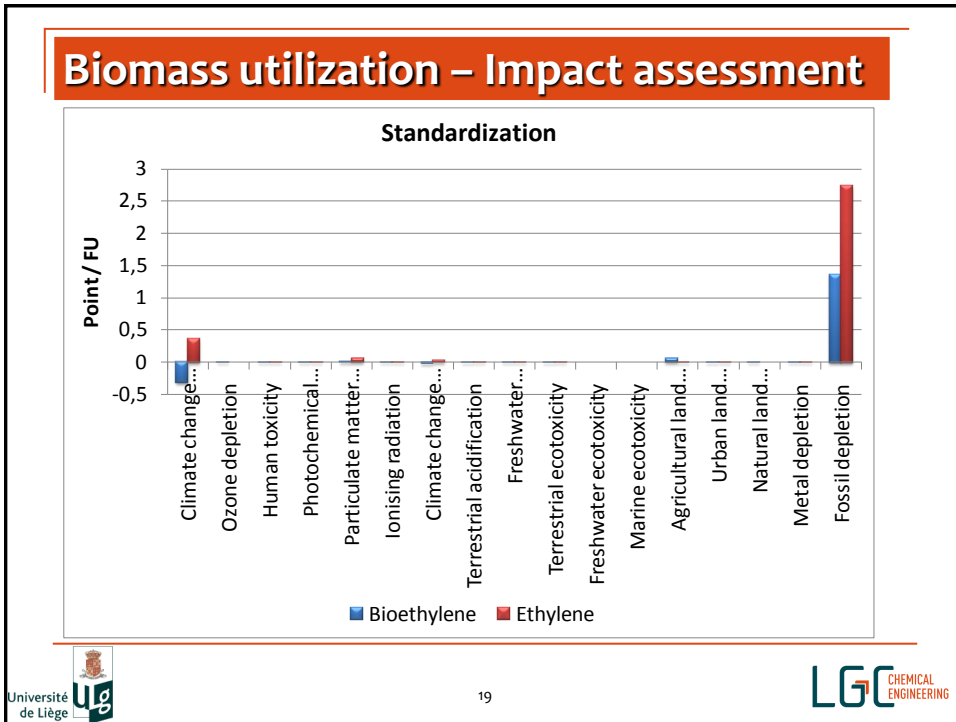
- Production of ethylene
 - Use of database

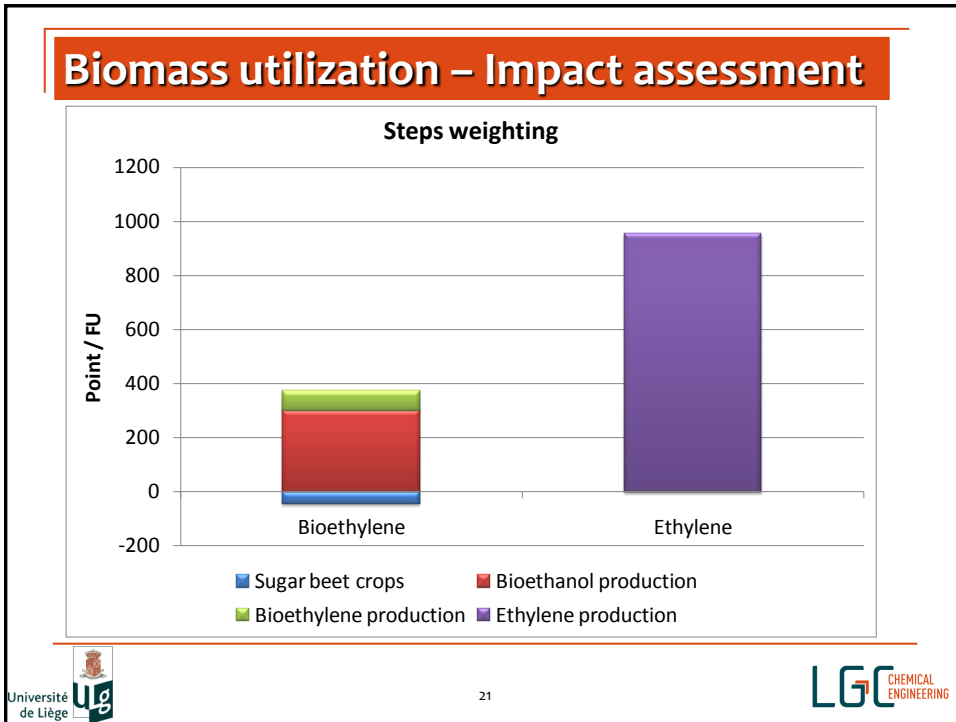
Biomass utilization – Impact assessment

- Estimate the potential environmental impacts using the results of the inventory
- Provide elements of information for the interpretation phase of the life cycle
- Existence of different methods

Biomass utilization – Impact assessment



- Methods depending on the desired response
 - Midpoint (e.g. Climate Change)
 - Impact 2002+
 - CML
 - ReCiPe
 - Endpoint (e.g. Human Health)
 - ReCiPe







Biomass utilization – Interpretation

- Bioethylene reaches a less important impact than ethylene for
 - Climate change
 - Fossil fuel depletion
- Limitation of the study
 - Soil transformation (pastures or forests to arable land → lost of carbon)


OR



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Perspectives – Biomass

- Life Cycle Assessment = environmental management tool
 - Decision support tool
 - Need of methodological developments for soil uses
 - Need of others tools for economic and sociological aspects → 3 pillars of sustainable development
- Biomass
 - Part of solution with good farmer management
 - Not only usable for energy → need to find the best way to use it

Perspectives – Biomass

- Use of LCA approach for other biomass-related topics
 - Biomass combustion, biomethanation or gasification
 - 2nd generation biofuels
 - 3rd generation biofuels
- Questions to answer
 - What is the best way to use energy crops?
 - Is it better to produce energy or chemical components?
 - How can we valorize waste?

Perspectives – Biomass

And you, what's your opinion?

