Use of Life Cycle Assessment to determine the environmental impact of gasification of lignocellulosic biomass: preliminary results

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Lignocellulosic biomass

Wood[1]

Energy crops

Miscanthus[3]

Straw[2]

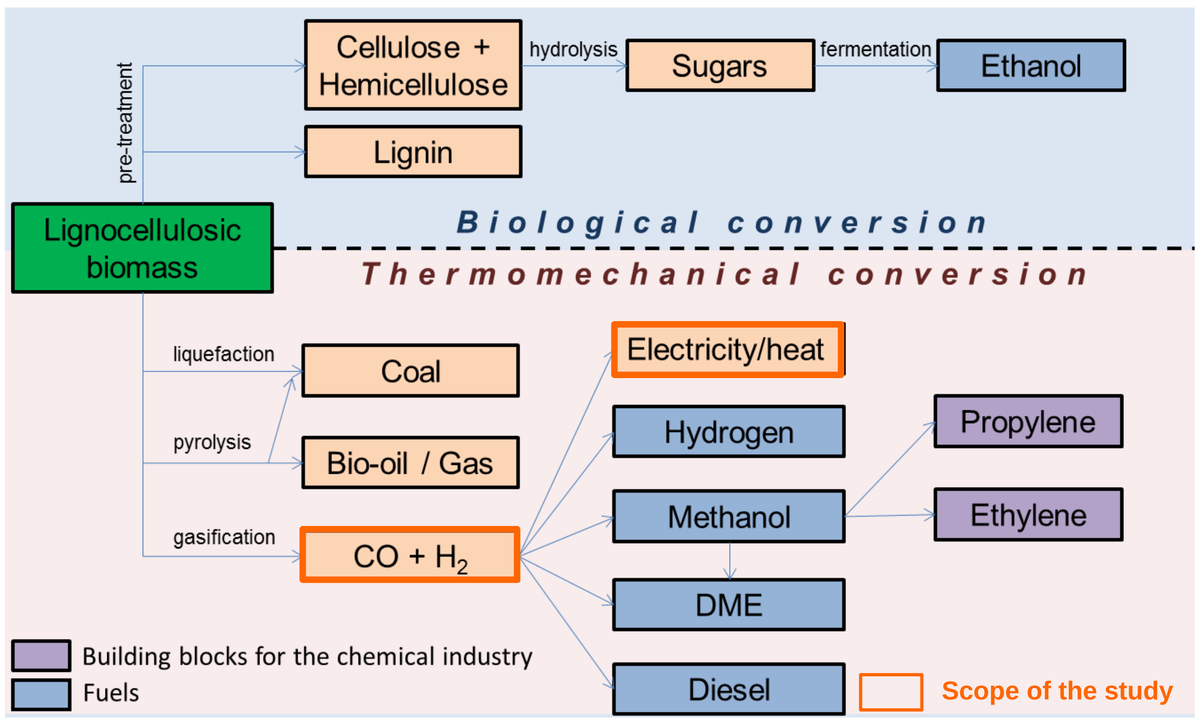
Biomass = promising energy source to replace fossil fuels.

Lignocellulose :

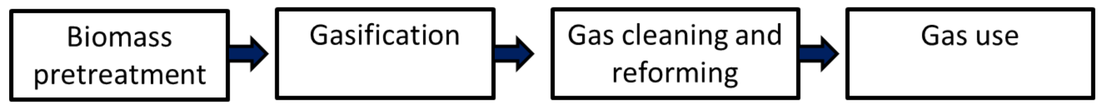
- Abundant in cheap and non-food materials
- Converted by second generation technologies : whole plant processed → better yield
- Less competition with food crops for land and water[4,5].

Lignocellulosic biomass: a sustainable alternative? ➔ **Life Cycle Assessment (LCA)** methodology to quantify its environmental impact.

Lignocellulosic biomass conversion processes



Process



Pretreatment

- **Size reduction**: particle size between 20 and 80 mm
- **Drying**: water content < 10%

Gasification

Biomass + Oxidizing agent → Syngaz

T= 600 – 1000 °C

Oxidizing agent:
- Air
- Oxygen
- Steam

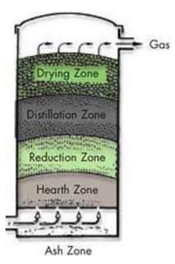
Heat supply:
- Allothermal or autothermal
- Direct or indirect

Component	% (volume)
CO	31-40
H_2	33-36
CO_2	23-35
CH_4	2-3

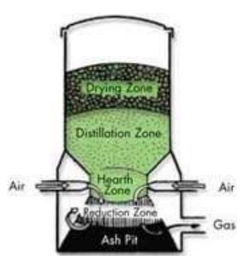
+ inertes

Scope of the study

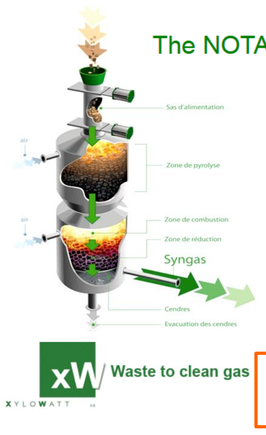
Reactor type



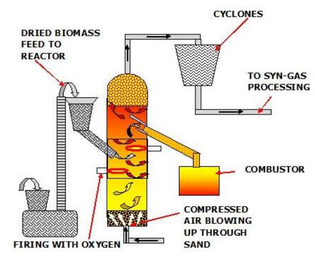
Fixed-bed updraft[7]



Fixed-bed downdraft[7]



Fixed-bed multistage[6]



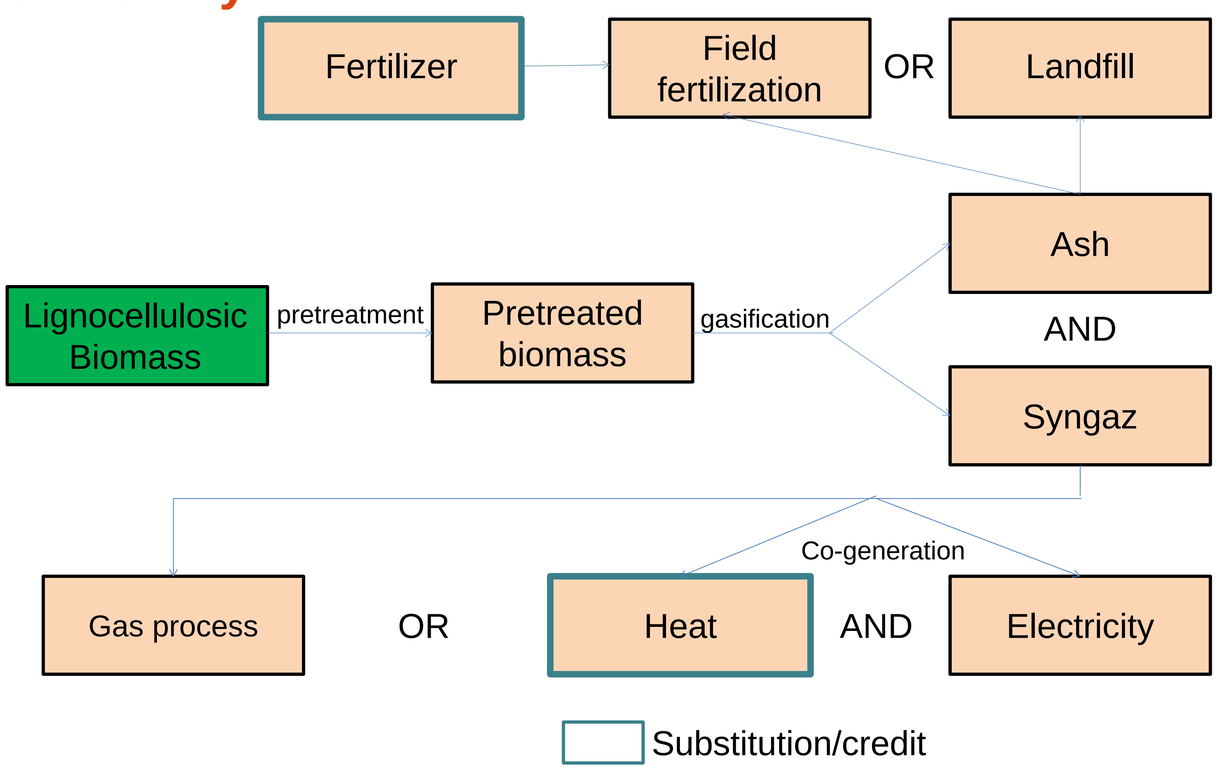
Fluidized-bed bubbling[4]

Gas cleaning and reforming

<u>Dependent on gas use</u>

- **Particle removal**: biomass (ash and char)+ bed → plugging
- **Alkali removal**
- **Nitrogen** and **sulfur compounds**: small amount
- **Tar elimination**: primary (in gasifier) or secondary technologies
- **Reforming**: Water-shift reaction : $CO + H_2O \leftrightarrow CO_2 + H_2$ ➔ H_2/CO

Our study



Wood gasification

Downdraft, fixed-bed two-stage gasifier XYLOWATT → Very **low amounts of tar**. This gasifier is generally considered to work close to the equilibrium state.

Small scale applications: cogeneration or used as process gas in furnaces.

Ashes end of life → Presently (Belgian legislation context): the ashes must be landfilled; in the future: field fertilization?

Co-product: system expansion by substitution (avoiding allocation procedure): the avoidance impact, from the co-product is subtracted to the system impact.

Part of a wider study: quantify the environmental impact of several uses of syngaz and comparing them with each other and more conventional fuels. ➔ Develop a better assessment of the environmental performances of currently uncommon but promising technologies ➔ Tool to help in the decision process.

Conclusions and perspectives:

Lignocellulosic biomass gasification: **Promising processes** for substituting fossil fuels (building blocks for the chemical industry and fuels).

Their environmental impact remains uncertain → **LCA methodology needed.**

Numerous possibilities → **sensitivity and uncertainity analysis**.

Take into account the impact of **biomass production.**

LCA : - Allows **comparison** bewteen biomass development and fossil technologies;
- Allows a **better understanding** of the environmental impact of the processes;
- Takes into account **several impact categories**.

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