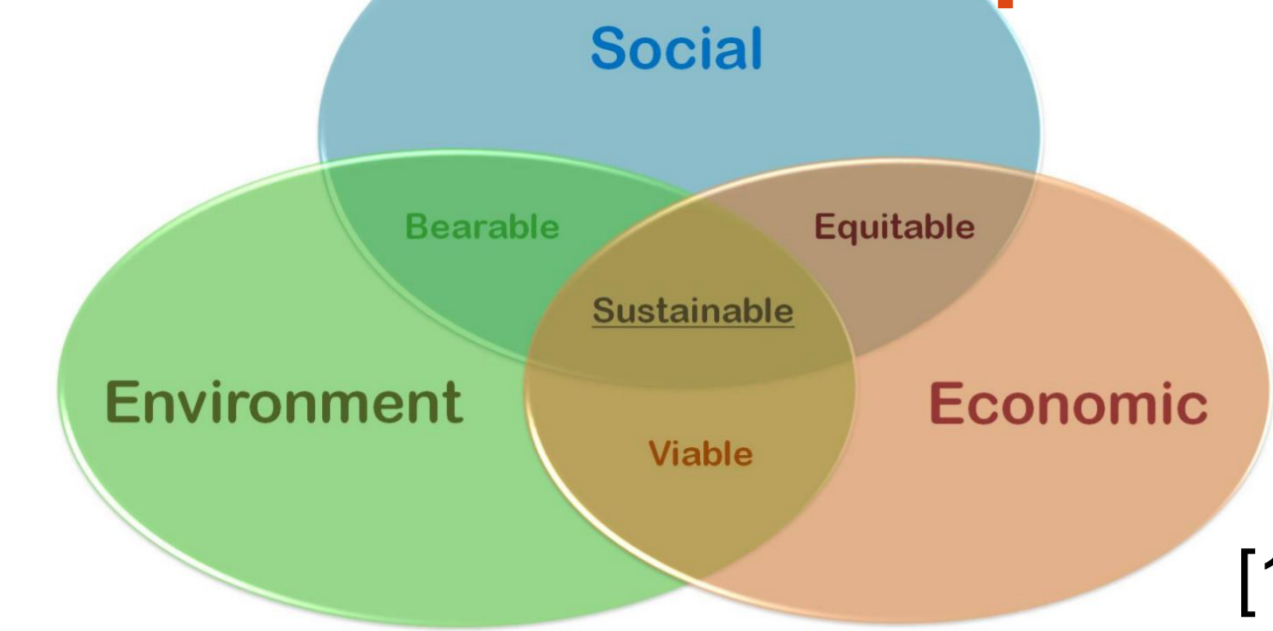


Use of Life Cycle Assessment to determine the environmental impact of thermochemical conversion routes of lignocellulosic biomass: state of the art

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Sustainable development



Biomass

- Limited fossil fuel resources
- Too much energy dependence

First generation:

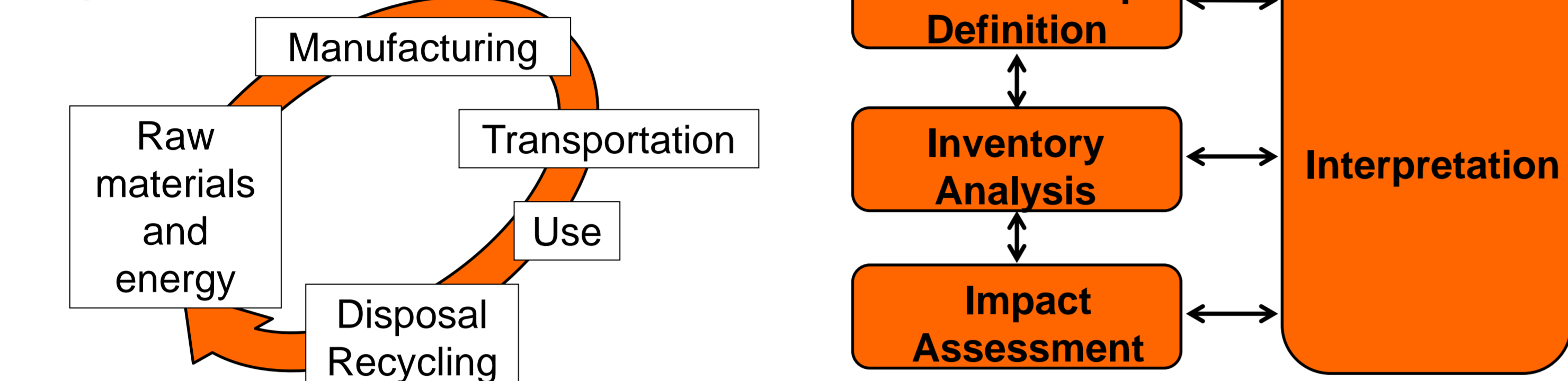
- High waste
- Low yield
- [1] → Competition for land / water with food crops

Lignocellulosic biomass (second generation technologies)

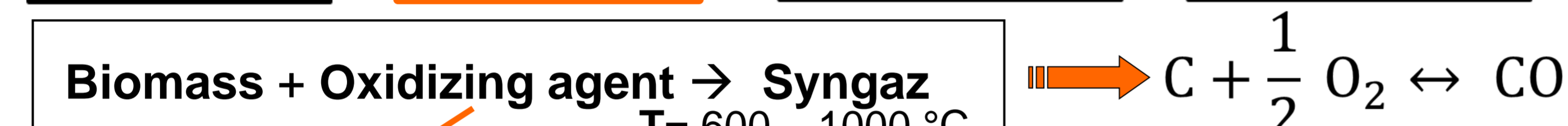
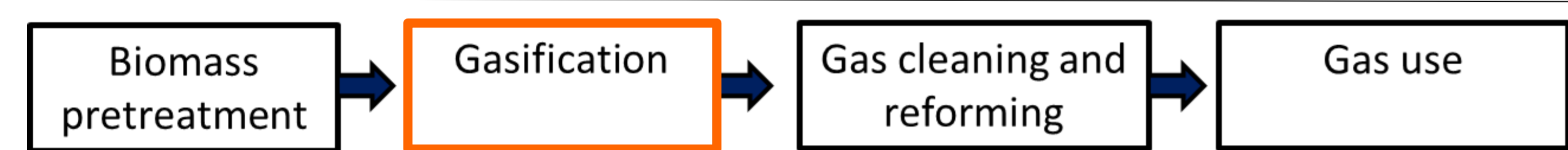
Abundant, cheap, and available in non-food plants: wood and energy crops such as miscanthus.

Environmental impact ? LCA (Life Cycle Assessment)

LCA



The LCA deals with the environmental aspects and potential impacts associated with all the stages of a product's life. The energy and material fluxes for the entire life-cycle are analysed with special attention to possible environmental or human health problems. A LCA consists of four interdependent steps defined by the ISO 14040 and 14044 norms [3,4].

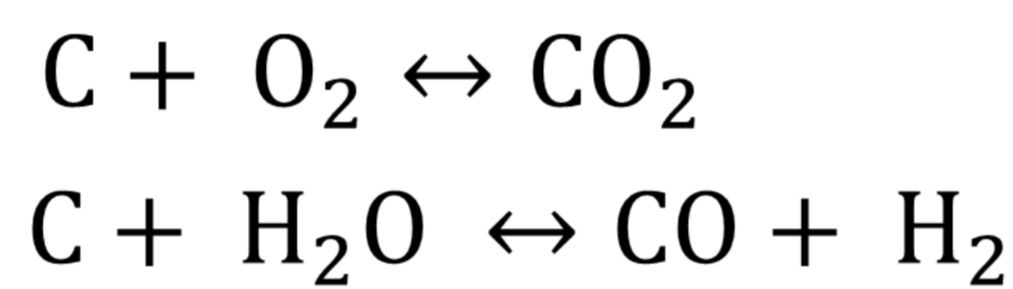


Oxidizing agent:

- Air
- Oxygen (gas with higher LHV)
- Steam (gas with more hydrogen)

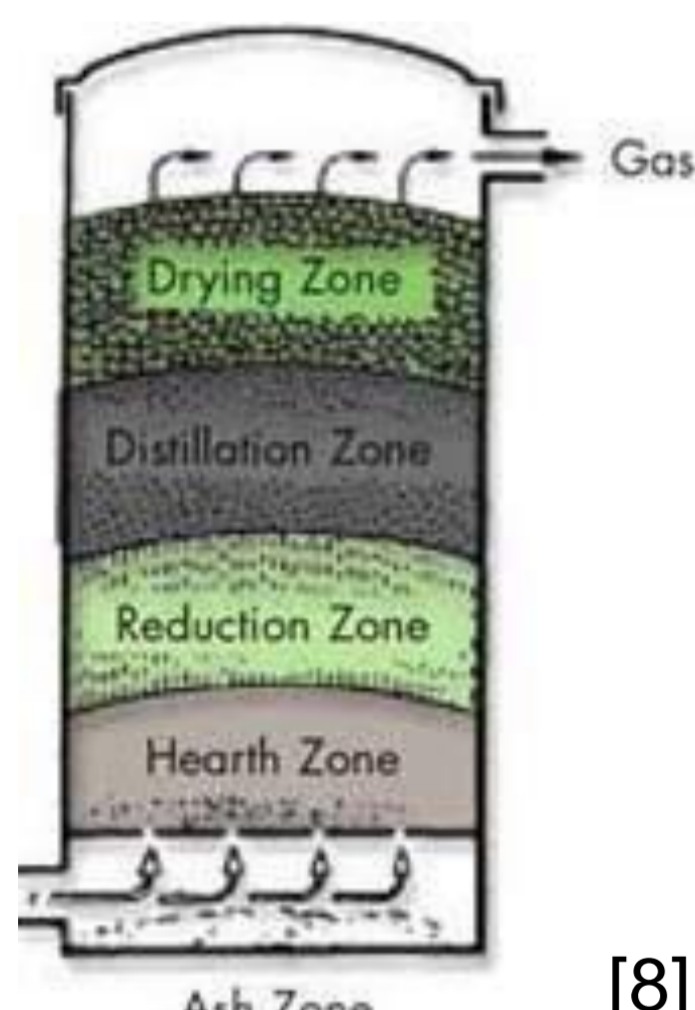
Heat supply:

- Allothermal or autothermal
- Direct or indirect

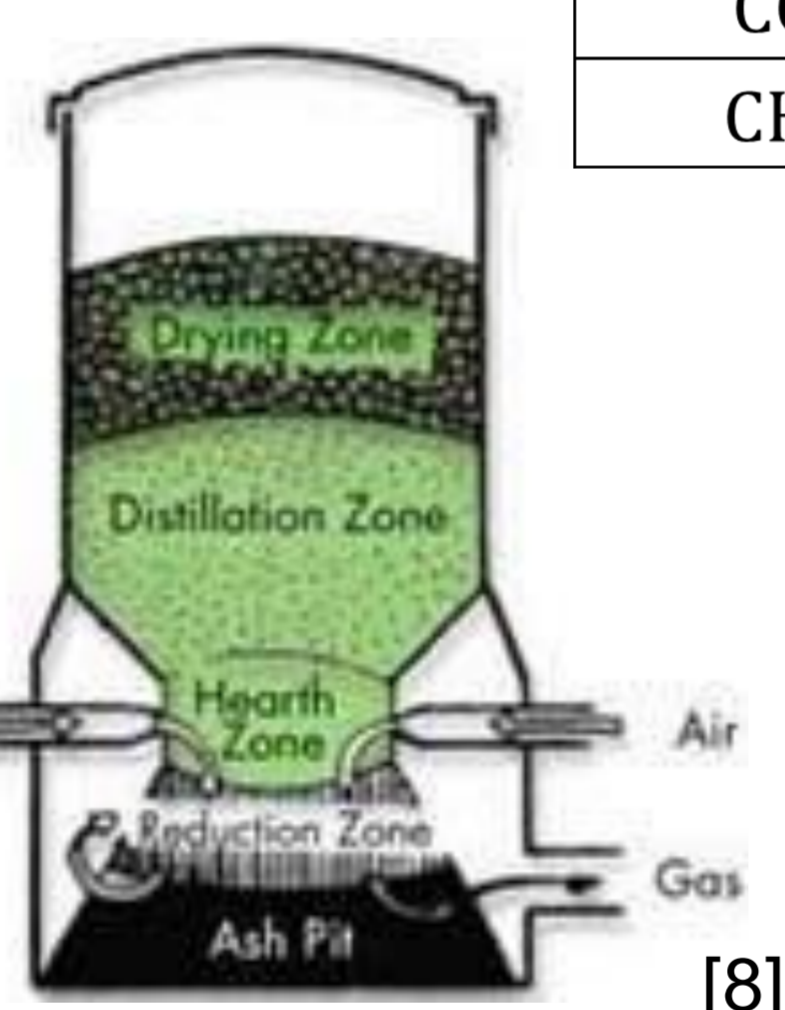


Component	% (volume)
CO	28-36
H ₂	22-32
CO ₂	21-30
CH ₄	8-11

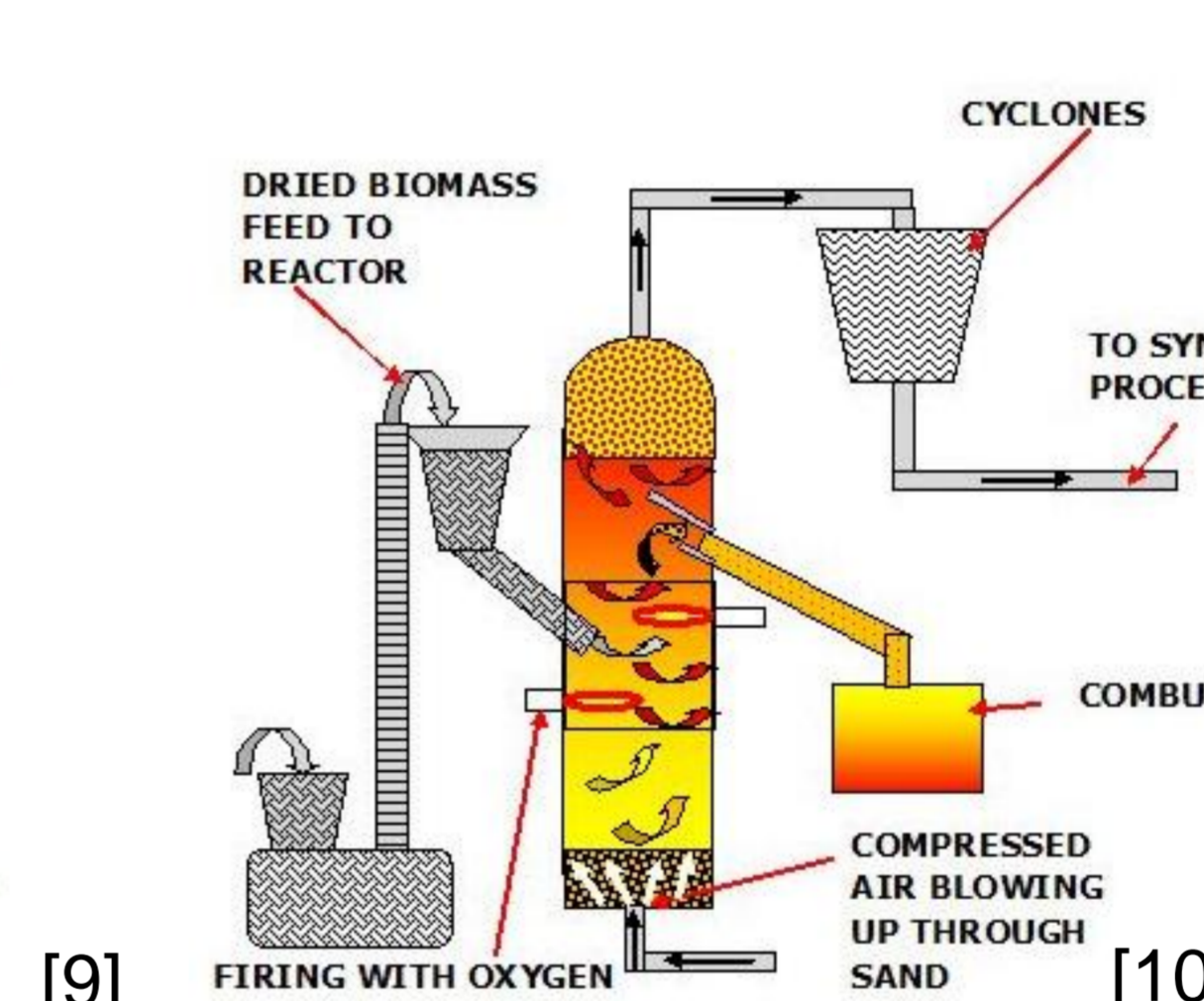
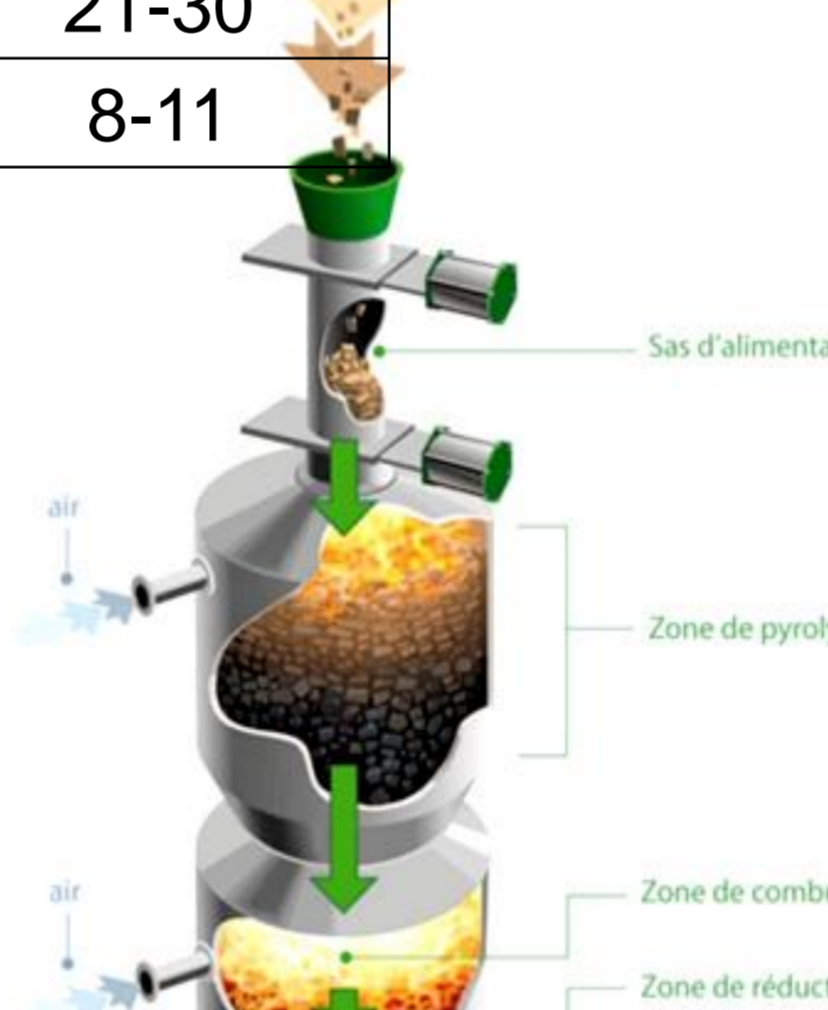
Oxidizing agent **flow rate**: Equivalent Ratio (ER): → ER → combustion → T → biomass conversion and fuel quality BUT → residence time and LHV.



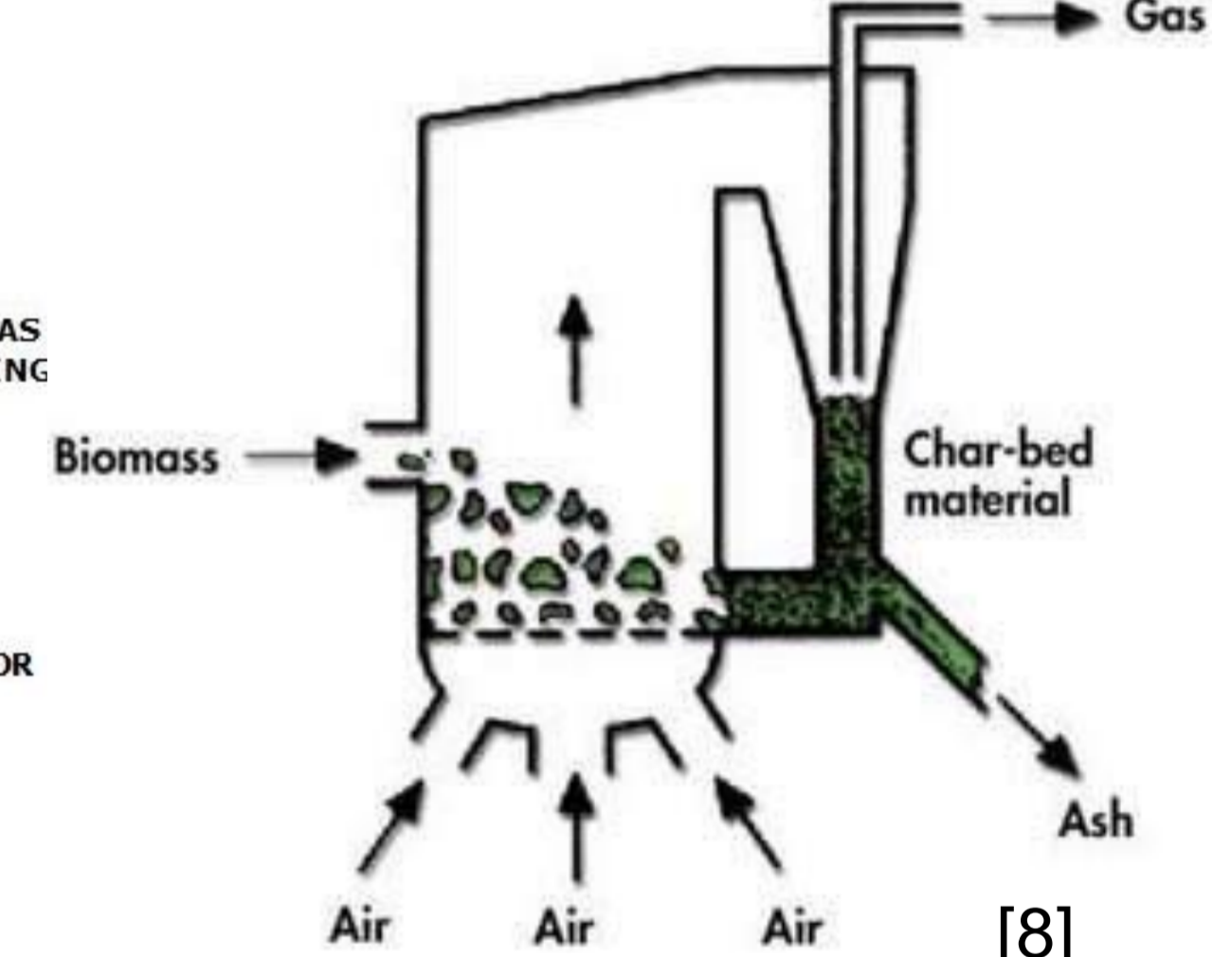
[8]



[8]



[9]

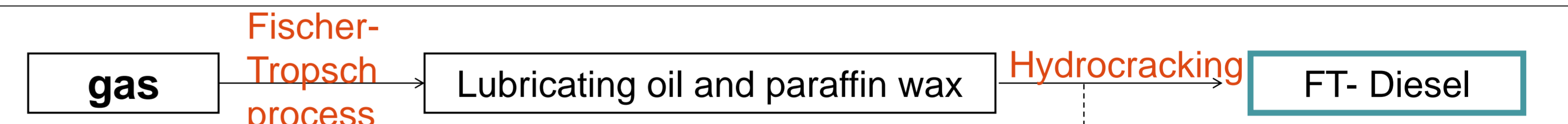
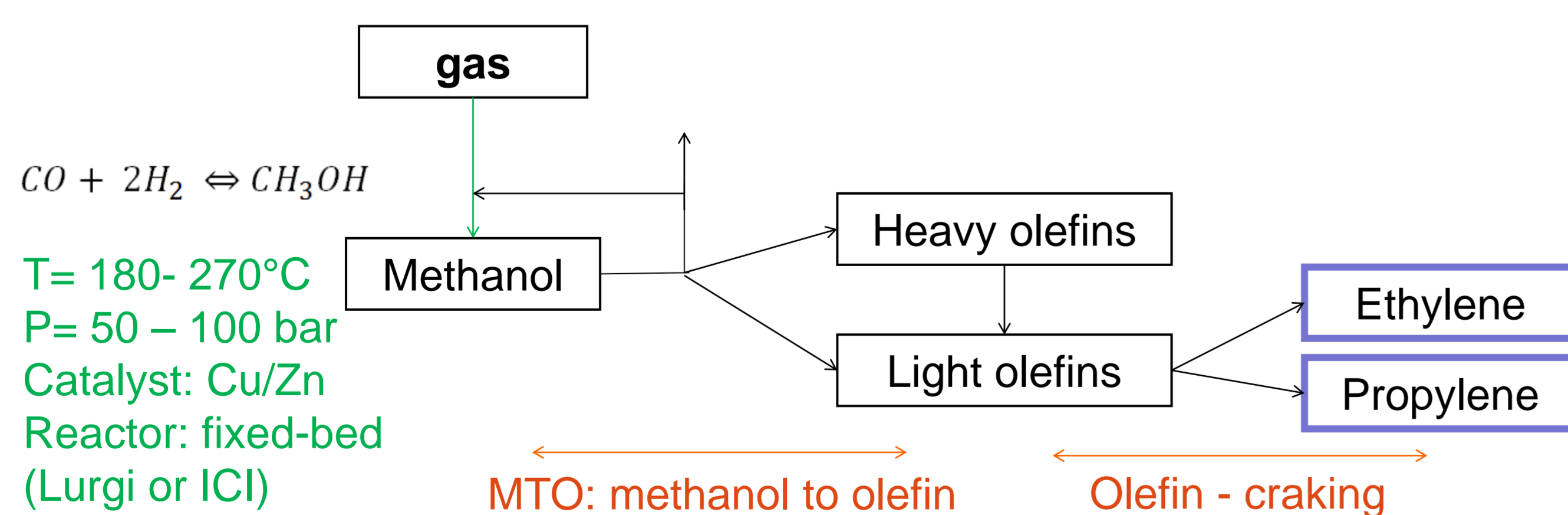


[8]

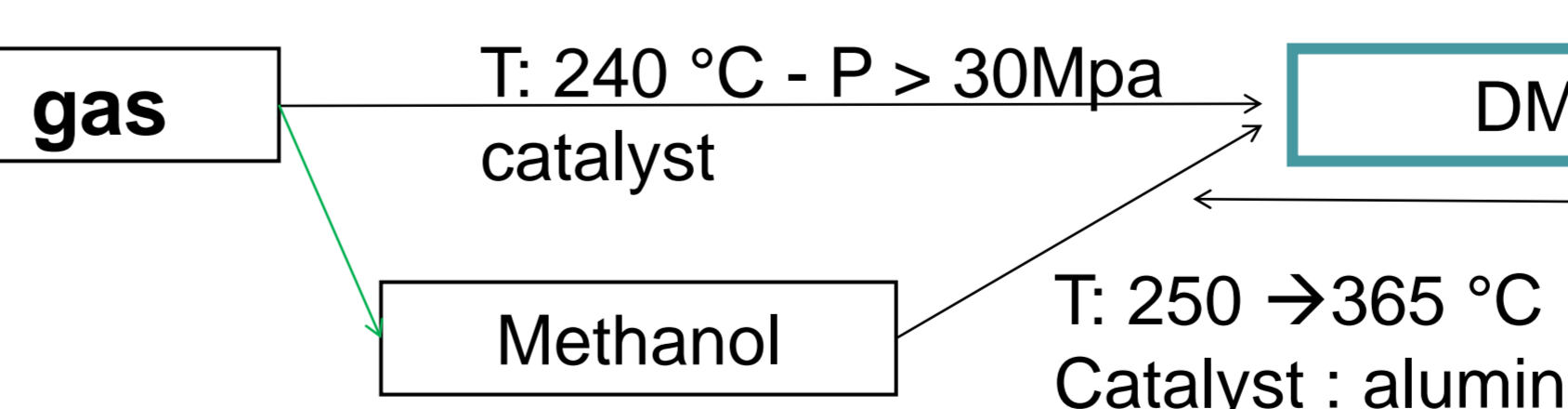
	Fixed-bed updraft	Fixed-bed downdraft	Fixed-bed multistage	Fluidized-bed bubbling	Fluidized-bed circulating
+	Easy Mature	Lower ash content Inexpensive	No tar	Uniform temperature High reaction rate	Low tar content Uniform temperature
-	High ash and tar content Only small scale	Biomass with small size and low water content Only small scale Hot gas at the exit	Biomass with small size	Biomass with very small size High ash content Complex	Only large scale High particle content Complex



Building blocks for the chemical industry



T: 220 - 250°C
Catalyst: Co or Fe
Reactor: fluidized bed or multi-tubular fixed bed



Empirical formula	CH ₃ O CH ₃
LHV (MJ/L)	18,2-19,3
Density (kg/L)	0,67
Cetane number	>60
Motor	Diesel or mixed with LPG

Conclusions and perspectives:

Promising processes for substituting fossil fuels. Their environmental impact remains unknown → LCA methodology
LCA adapted to include land use change effect. Practical example: miscanthus culture in Belgium

Economic viability assessed → decision making tool

Bibliography

1. Sustainable development. Glossary 2011 [cited 2012 31-01-2012]; Available from: <http://www.greentimes.com.au/lifestyle/sustainable-development.html>.
2. Naik, S.N., et al., Production of first and second generation biofuels: A comprehensive review. Renewable and Sustainable Energy Reviews, 2010. 14.
3. ISO, ISO 14040 : Management environnemental - Analyse du cycle de vie - Principes et cadre, ISO, Editor. 2006.
4. ISO, ISO 14044 : Management environnemental - Analyse du cycle de vie - Exigences et lignes directrices, ISO, Editor. 2006.
5. Kumar, A., D.D. Jones, and M.A. Hanna, Thermochemical Biomass Gasification: A Review of the Current Status of Thechnology. Energies, 2009. 2
6. Warnecke, R., Gasification of biomass: comparison of fixed bed and fluidized bed gasifier. Biomass & Bioenergy, 2000. 18.
7. An Overview of Biomass Gasification. [cited 2011; Available from: http://arkansasenergy.org/media/143168/overview_biomass_gasification.pdf
8. Community development library, gasification, [cited 2012; Available from: <http://www.greenstone.org/greenstone3/nzdl;jsessionid=07001AC50F490ADE7B6F119FBC17633F?a=d&c=cdl&d=HASH10b0eb9f4e955c5d59180b.10.1.np&sib=1&p.s=ClassifierBrowse&p.sa=&p.a=b>
9. Xylowatt. XYLOWATT : Technologie NOTAR®, production de gaz propre. [cited 2011 3-10-2011]; Available from: <http://www.xylowatt.com/La-gazefication-XYLOWATT/g-xylowatt-technologie-notarr-production-de-gaz-propre.html>.
10. Bright Hub, Mobile Biomass crop or Waste Processing [cited 2012; Available from: <http://www.brighthub.com/environment/renewable-energy/articles/85799.aspx>