Pro's and con's of of bio plastics in a lifecycle perspective

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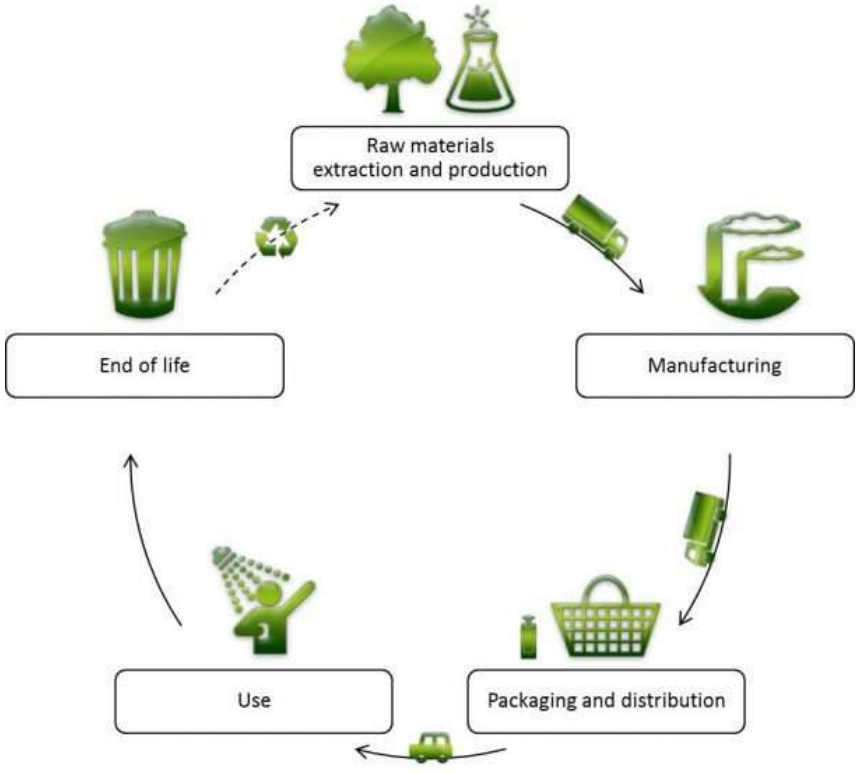
What is LCA ?


Raw materials
extraction and production
Manufacturing
Packaging and distribution
Use
End of life

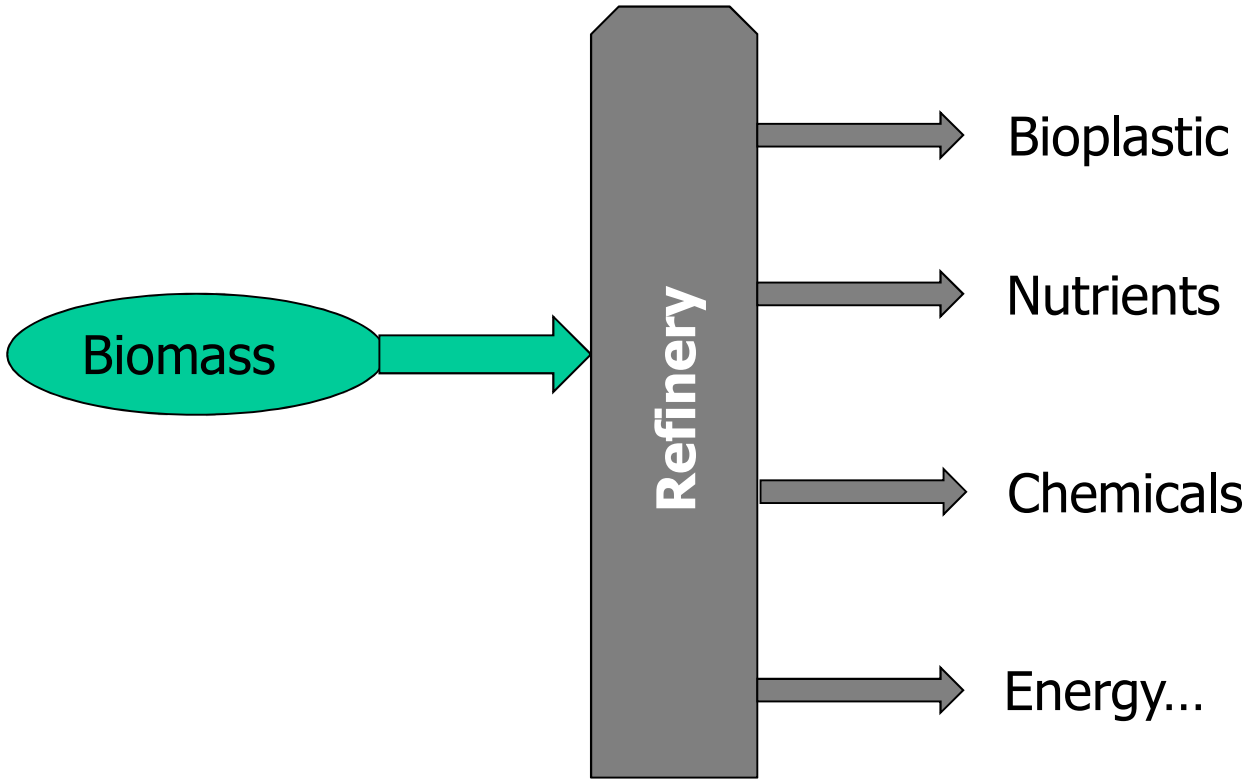
Environmental indicators

LCA impact categories	Unit
Acidification	Mole of H+ equiv
Climate change, excl biogenic carbon	kg CO2-equiv
Climate change, incl biogenic carbon	kg CO2-equiv
Ecotoxicity freshwater	CTUe
Eutrophication freshwater	kg P eq
Eutrophication marine	kg N eq
Eutrophication terrestrial	Mole of N eq.
Human toxicity, cancer effects	CTUh
Human toxicity, non-cancer effects	CTUh
Ionizing radiation, human health	kBq U235 eq
Land use	kg C deficit eq
Ozone depletion	kg CFC-11 eq
Particulate matter/Respiratory inorganics	kg PM2,5-Eq
Photochemical ozone formation, human health	kg NMVOC
Resource depletion, elements	kg Sb eq
Resource depletion, fossils	MJ

Statements

- European Bioplastics, 2017 (trade organisation):
  - There is no such thing as 'The ONE Life Cycle Assessment of ALL bioplastics'. An LCA applies to a specific product or service, not to bioplastics in general or all products available
  - Ensure that environmental claims are specific, accurate, relevant and truthful.
  - Be careful with general claims that do not fulfil these criteria (eg. "green", "sustainable", "environmentally friendly", "climate friendly"...)

Bio-refining



- The environmental profile of the bioplastic also depends on the allocation among outputs !

Same molecules, (almost) the same properties

- Identical materials, produced by either fossil or renewable ressources, also have identical properties in relation to processing, use and reuse/recycling:
  - Exampel: PE (polyethylene) and bio-based PE are the same

- BUT not with regards to incineration
  - CO_2 from incineration of bioplastic does generally not contribute to climate change

Functional unit is always important

- It is important to remember the functional unit when comparing:
  - Maybe a thinner foil is needed with an alternative material
  - Maybe the waste increases when processing a new material
  - Maybe the plastic packaging has an influence on the durability of a food
- One kg traditional plastic (eg. PP) does not necessarily compare with one kg of bio degradable plastic (eg. PLA)
- BUT: One kg PE does compare with one kg bio-PE

Relative impacts - raw materials (per kg) - not including climate change !!

The bio-LDPE comparison is based on sugar canes, wheet, beet and corn !

The PP and PET comparisons is only done for bio-plast from sugar cane !

Impact:	LDPE bio vs. fossil	PP bio vs. fossil	PET bio vs. fossil
Acidification			
Eco tox. (fresh water)			BIO
Eutrophication (fresh water)			
Eutrophication (marine)			
Eutrophication (terrestrial)			
Human tox. (cancer)	><		BIO
Human tox. (non-cancer)			BIO
Ionizing radiation			BIO
Land use			
Ozone depletion			BIO
Particulate matter			
Photochemical ozone formation			
Resources – elements			BIO
Resources – fossil	BIO	BIO	BIO

Climate change – Life cycle - incineration

- When disposal by incineration is considered, the biobased plastics have a lower contribution to climate changes!

- Climate changes enjoy a great, almost unique, global attention in comparison with other environmental impacts!

End-Of-Life – bio degradable plastic

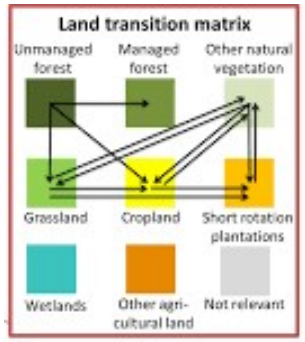
- Some types of biodegradable plastic can help reduce problems with plastic waste in nature:
  - If the waste handling system is suitable (and if properly tested and documented)
  - Can disrupt current plastic recycling systems
  - Oxo-, photo and water soluble plastic, which is not bio degradable, is assumed to contribute to micro plastic in the environment !

Cautious conclusions & perspectives

- Biobased plastic will often contribute less to climate change than conventional plastic
  - Particularly when End of Life is incineration
- Biobased plastic will often require less fossil resources (oil, gas) in comparison with conventional plastic
- The most common bioplastics often have a higher impact to other types of environmental impacts compared with fossil plastic:
  - Depending on plastic type, raw material, cultivation method and product application
  - Land use
- Some types of biodegradable plastic can help reduce problems with plastic waste in nature
  - But can be problematic for plastic material recycling

Land use change bioplastic study:

- Quantifies global land use mediated GHG emissions due to an increase in demand for bioplastics, considering direct LUC and also indirect LUC, which arises from economy-wide interactions.

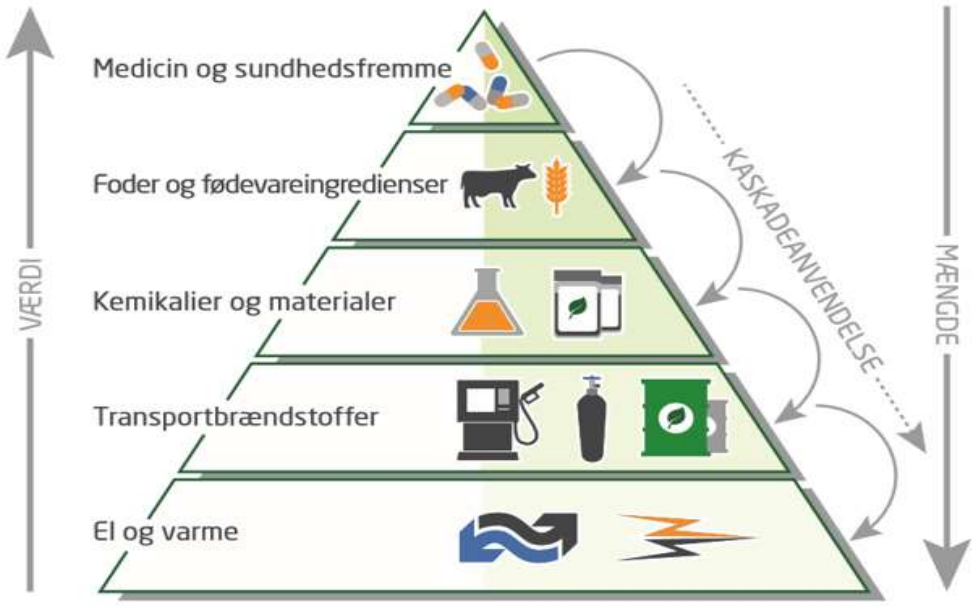


- Results show that increased bioplastic consumption leads to deforestation and GHG emissions from LUC on a global scale.

"Land use mediated GHG emissions and spillovers from increased consumption of bioplastics" by Neus Escobar et al, dec. 2018 – Bonn University

Land use

- Biomass is versatile: e.g. ethanol can be used for bioplastic or as fuel replacing gasoline !
- Bioplastics are made from renewable resources, but not unlimited resources !
- How to get the most value from the land use,
  - Biomass use efficiency
  - Transportation
  - Recycling and number of uses (value per m^2)
  - Replacing what ?
- Fossil plastic industry more mature -> R&D expected to improve bioplastic profiles



Source: DTU sektorudviklingsrapport om bioøkonomi, 2019

QUESTIONS ?