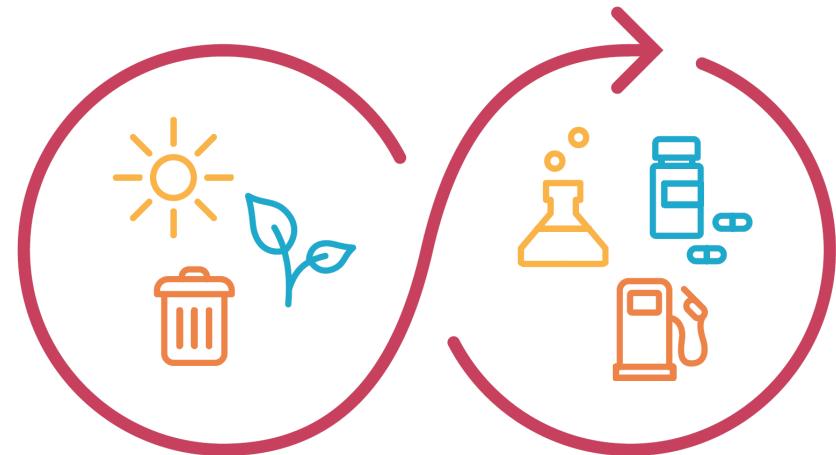


Bio-based Chemicals



Group 4

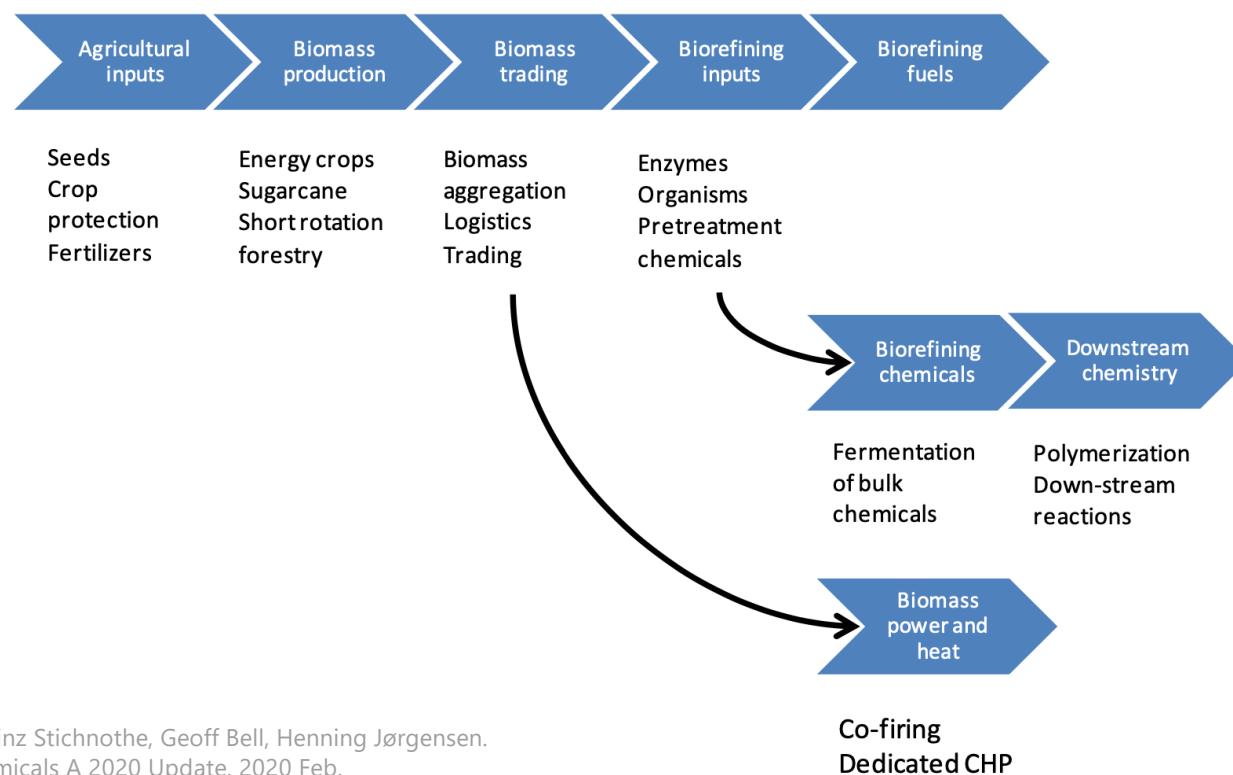
Introduction



- **Bio-based chemicals:** produced from a renewable biological source rather than fossil fuels
- **Across the globe:** shift towards a bio-based economy
- **Biorefinery definition:** “Sustainable processing of biomass into a spectrum of marketable products and energy”

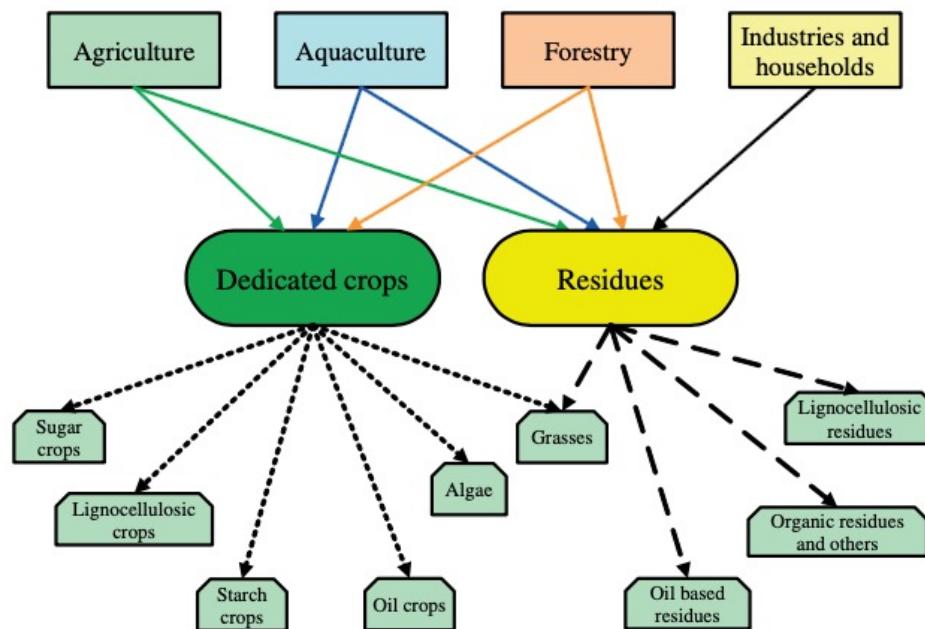
Bio-based product value chain

- **Integrated biorefinery process:** more efficient and better valorisation of biomass resources

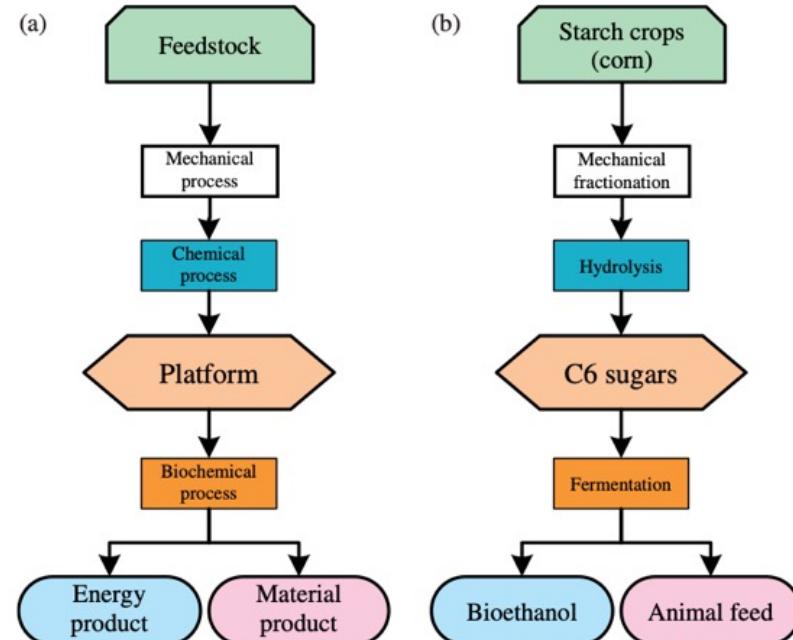


Biorefinery process

■ Major feedstocks



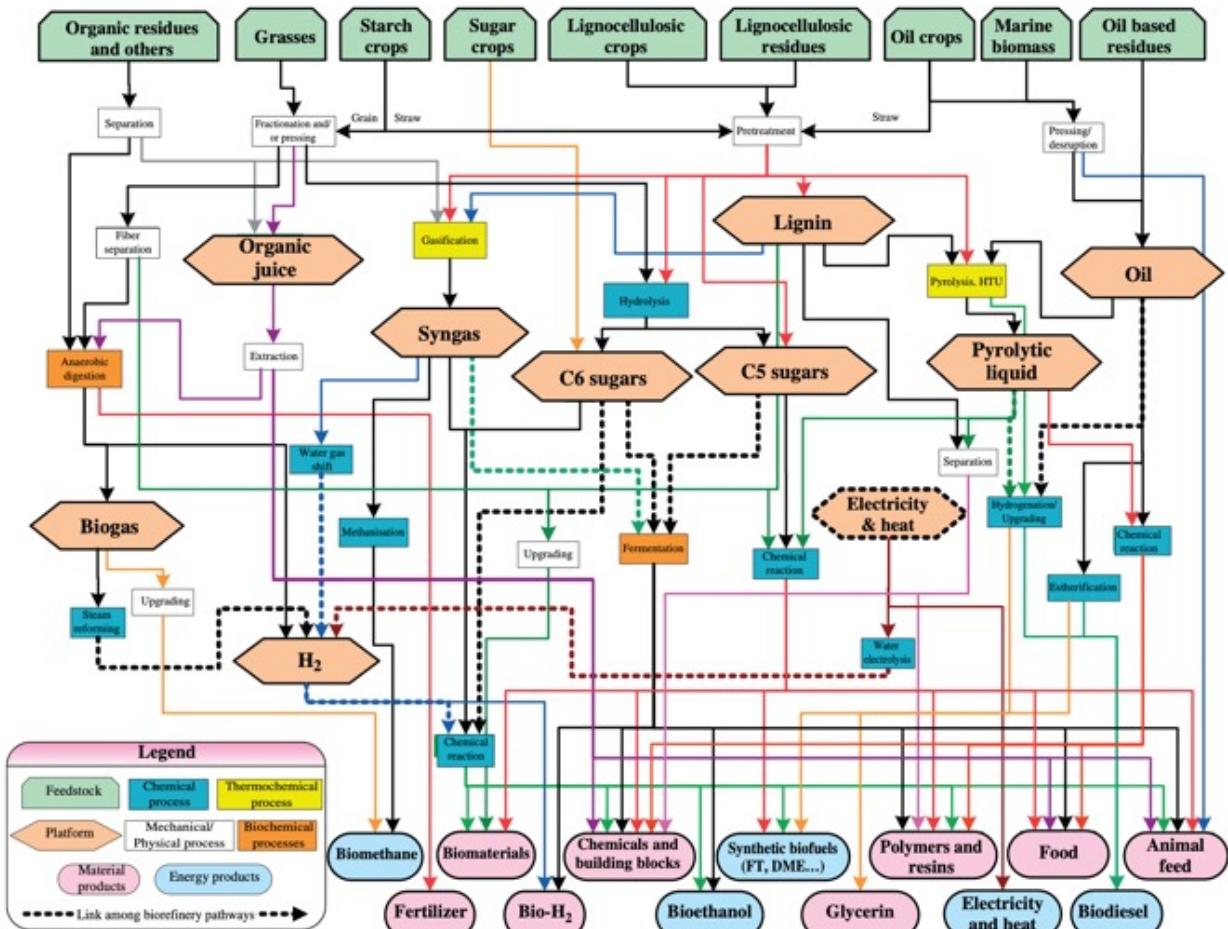
■ Biorefinery system



Cherubini F, Jungmeier G, Wellisch M, Willke T, Skiadas I, Van Ree R, et al. Toward a common classification approach for biorefinery systems. *Biofuels Bioprod Biorefining*. 2009;3: 534–546. doi:10.1002/bbb.172

Biorefinery network

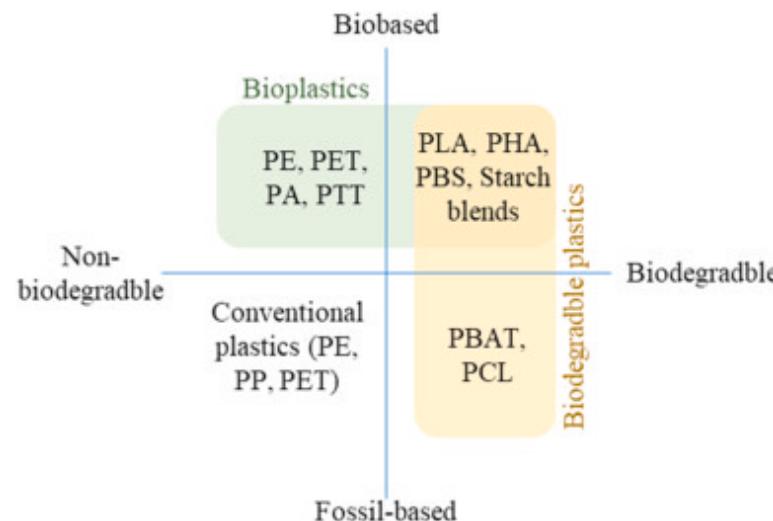
- **One platform:** often a mixture of compounds
- **Several feedstocks:** same platform
- **One biorefinery:** several platforms
- **Most relevant platforms:** Biogas, Syngas, Hydrogen, C6 & C5 sugars, Lignin, Pyrolysis liquid, Oil, Organic residues, Electricity & Heat



Cherubini F, Jungmeier G, Wellisch M, Willke T, Skiadas I, Van Ree R, et al. Toward a common classification approach for biorefinery systems. Biofuels Bioprod Biorefining. 2009;3: 534–546. doi:10.1002/bbb.172

Environmental benefits

- **Lower Greenhouse Gas (GHG) Footprint:** the majority of the bio-based products have on average lower GHG footprint than their fossil counterparts (~45% lower).
- **Renewable feedstocks:** products derived from renewable biological sources, such as sugarcane, corn, and cellulose
- **Biodegradability:**



E.A.R. Zuiderveen, K.J.J. Kuipers, C. Caldeira, S.V. Hanssen, M.K. van der Hulst, M.M.J. de Jonge, A. Vlysidis, R. van Zelm, S. Sala, M.A.J. Huijbregts, The potential of emerging bio-based products to reduce environmental impacts, *Nat. Commun.* 14 (2023); H. Mousavi-Avval, K. Sahoo, P. Nepal, T. Runge, R. Bergman, Environmental impacts and techno-economic assessments of biobased products: A review, *Renew. Sustain. Energy Rev.* 180 (2023)

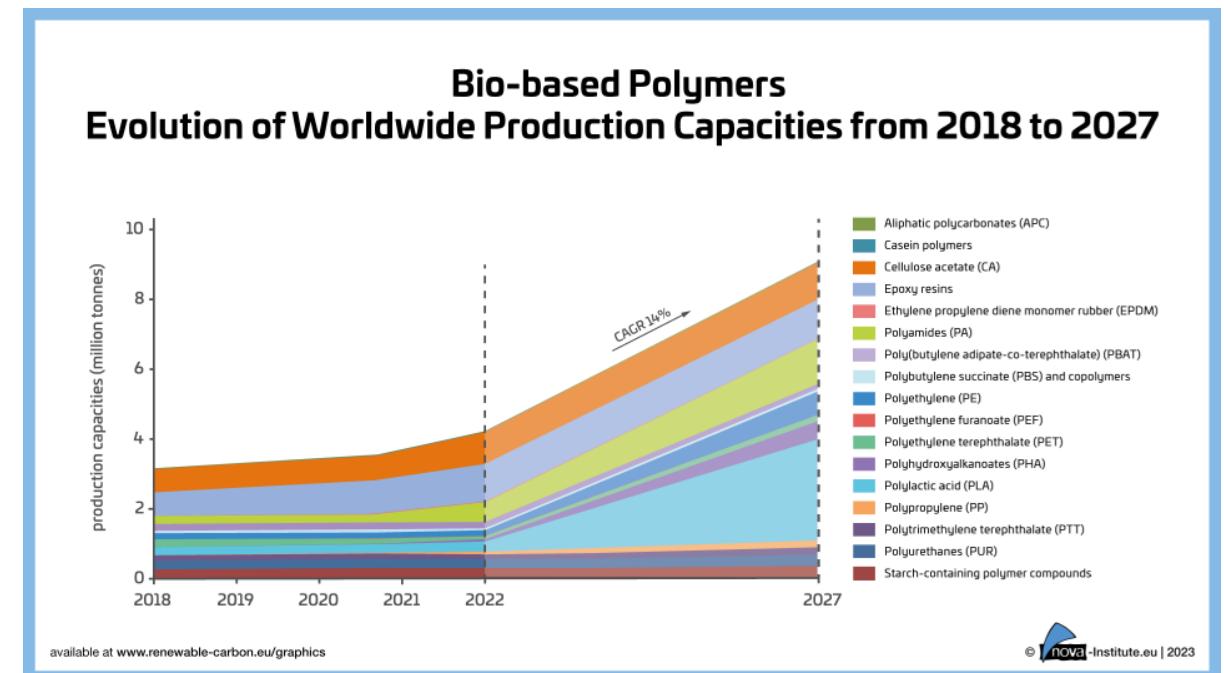
Social benefits

- **Health and Safety Improvements:** Biobased chemicals are often less toxic than their petroleum-derived equivalents → safer industrial processes.
- **Rural Development and Job Creation:** Supports farmers and local economies using agricultural by-products → Stimulates rural economies



Economic benefits

- **New Market Opportunities:** growth of bio-based industries leads to innovation and job creation in innovative sectors and in rural and coastal areas.
- **Supply Chain Resilience:** Less vulnerability to oil price fluctuations and geopolitical risks.
- **Government Incentives:** Many countries provides subsidies and regulations favouring bio-based industries.



Drawbacks : Bio-diversity loss and soil Degradation

- **Increased land demand:** Extensive amounts of forests, land need to be **exploited** to obtain sufficient biomass. If monoculture intensive farms are created, then it will **reduce diversity** in the region.
- **Effects on soil:** Intensive "harvesting" will **degrade land** over time, increasing **erosion** and reducing **fertility**.



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Drawbacks : Water stress and competitions with other sectors

- **Biomass production** will lead to **increased water consumption** leading to more **draughts** in arid prone areas.
- **Transport** and **initial treatment** will be **costly** and increase CO₂ output.
- Bio based plastics and other products demand far **more water** than their oil-based counterparts.
- In addition of water, the demand for biomass **competes** with food production, forestry, and energy sectors, leading to potential land-use conflicts.

Current Key Barriers

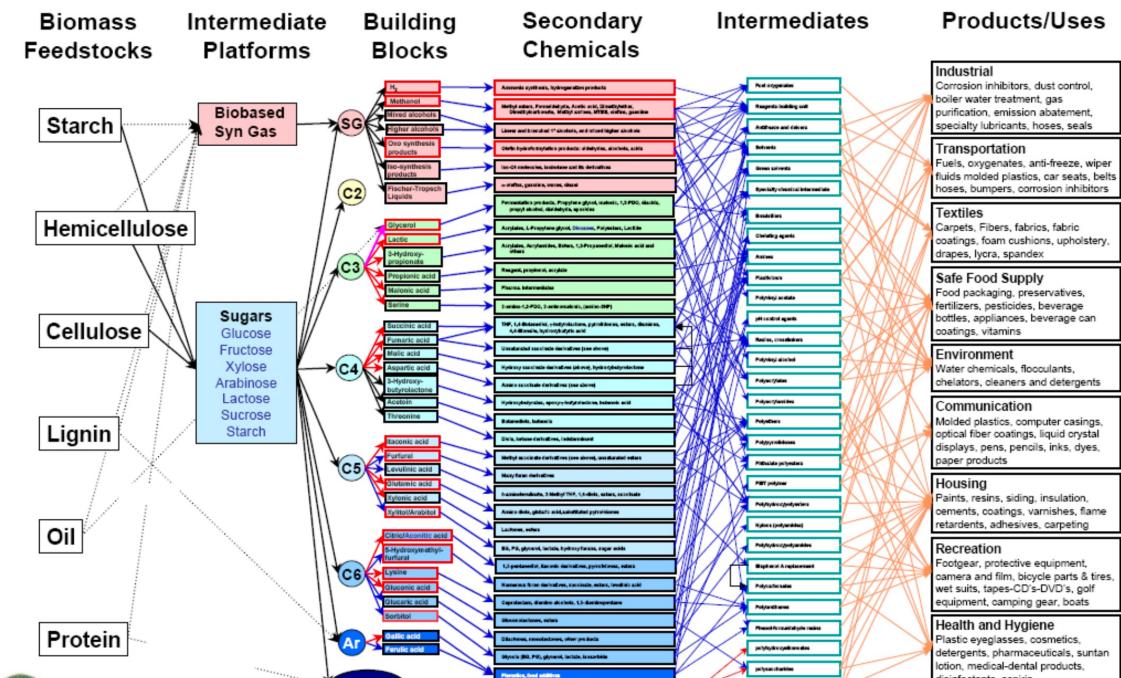
■ **Economic challenges**

- **High capital investment**

on biorefineries: Important cost of new technologies to treat biomass (several different primary feedstock materials that can be transformed into many intermediates and products)

- **Cost competitiveness**

with fossil-based chemicals: Oil is usually cheaper to extract and transport. All the industry is adapted to oil refinement and has been improving for decades.



(Werpy, Holladay, and White 2004)

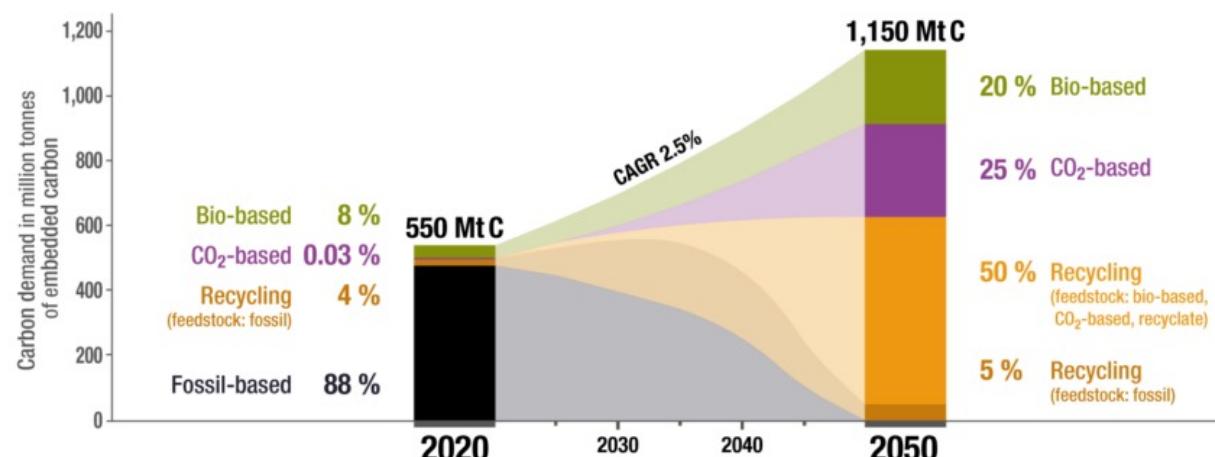
Current Key Barriers

■ Social & political challenges

- Public Perception and Awareness
- Regulatory and Policy Uncertainty
- Social and Cultural Factors

■ Social & political opportunities

- Policy Support and Incentives
- Public-Private Partnerships
- Consumer Education and Engagement
- Investment in R&D



Conclusion

- **Bio-based chemicals:** Produced from a renewable biological source rather than fossil fuels.
- **Biorefinery process:** Many and varied raw materials, complex process with multiple stages and intermediates and different products.
- **Many benefits:** Environmental, Social and Economic
- **Several drawbacks:** Water stress and large area-surfaces being the most important.
- **Current Key Barriers:** Neither affordable nor competitive, ineffective policies and regulations.

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