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THE BIOGENIC CARBON LOOP IN THE PULP AND PAPER SECTOR: AN ALTERNATIVE TO FOSSIL CARBON IN OTHER INDUSTRIES

The paper industry's untapped potential to contribute to a de-fossilised economy.

Executive summary

The pulp and paper industry has a great potential for capturing biogenic carbon. It is already tapping into it and has the capacity to scale it up rapidly. In an industrial context, biobased carbon in turn holds the possibility to substitute fossil carbon used in linear economic models with biogenic carbon, used in a circular way.

Petrochemical-based sectors have already signalled their need for alternatives to fossil carbon, in order to reach the EU's 2050 net-zero objectives. But it remains to be known what a likely demand for biogenic carbon from these sectors could be, and how it will develop over time. On commission by Cepi, the nova Institute reviewed 9 recent studies explore this future demand and identified some emerging key trends.

In most scenarios of the studies, the share of biomass is between 20 and 40% of the total demand.

Most studies see a clear role for biogenic carbon in the future of the chemical industry and recognise its potential to substitute fossils.

- In the studies where biomass is analysed in more detail, the biomass demand is mainly met with wood and biogenic waste as well as agricultural raw materials containing lignocellulose.
- The utilisation of CO_2 towards 2050 is estimated by the majority to be somewhat lower than that of biomass, between 10 and 30%. Depending on the studies, either all CO_2 sources are accepted (biogenic as well as fossil point sources and air capture), or fossil point sources are disregarded.

In all studies about future carbon feedstocks for the chemical industry, biomass and recycling are considered as possible alternative carbon sources to replace fossil carbon.

Despite different models, assumptions and observation areas, the results of all studies are not very far apart, and on the contrary show a general alignment. The biggest differences are found within individual studies due to the various scenarios considered within a respective study.

- Some studies come to a share of zero for fossil carbon, in other words a full de-fossilisation. In other scenarios high fossil shares remain, often combined with high utilisation of CCS.
- The growth rates of the feedstock demand for the chemical or plastics industry in eight of the studies are between 1 and 4% CAGR, depending on the scenario, with most scenarios between 2 and 3% CAGR.

Report	Scope	CAGR	Share Bio-based	Share CO_2- based	Share Recycling
Ishii et al. /Systemiq 2022	Chemical Industry (cracker) 2020-2050	3%	up to 43%	up to 45%	up to 3%[1)]
OECD 2022	Plastic Sector 2019-2060	2.4%	3%	-	12%
RCI/nova 2022	Chemical Industry (cracker & more) 2020-2050	2.7%	20%	25%	55%
RCI/nova 2023 published)	Chemical Industry (heavy oil fraction) 2050	2.5%	40% (mainly lignin & pyrolysis oil)	20% (mainly FT)	40% (pyrolysis oil)
Lange, J.-P. 2021 (Shell)	Chemical Industry (cracker & more) 2020-2100	a) 4% by 2050, 2% by 2100 b) 4% by 2025, 2% by 2100	40% (1G 10%, 2G 30%)	10%	50% (mech. 15%, chem. 35%)
Orth et al. 2022	Plastic Sector 2020-2050 (EU)	4%	90% renewable carbon (authors use the term "zirkuläre Rohstoffe"), 10% fossil carbon		
Meys et al. 2021 (Carbon Minds)	Chemical Industry (cracker) 2050	ca. 4%	21%	33%	45% (20% mech. 25% chem.)
CEFIC 2021, iC2050	Chemical Industry (cracker) 2050 (EU27)	high electr.: 2.2% circ.: 1.1% sust. biomass: 2.3% CO_2 capt.: 1.1% (4 scenarios based on feedstock demand)	high electr.: 27% (60% fossil) circ.: 17% (54% fossil) sust. biomass: 35% (53% fossil) CO_2 capt.: 1% (88% fossil)	high electr.: 13% (60% fossil) circ.: 29% (54% fossil) sust. biomass: 12% (53% fossil) CO_2 capt.: 11% (88% fossil)	low: 35% (mech. 27%, chem. 8%) medium: 48% (mech. 31%, chem, 17%) high: 65% (mech. 33%, chem. 32%)
Material Economics 2019	Plastic Sector 2050 (EU)	scenarios show lower demand in 2050 because of efficiency	27 to 33% (three scenarios) ; bio-based plus CO_2 "at least 38%"	CO_2 as feedstock is covered, but without separated quantification	25 to 53%[2)] (three scenarios), max. 62%

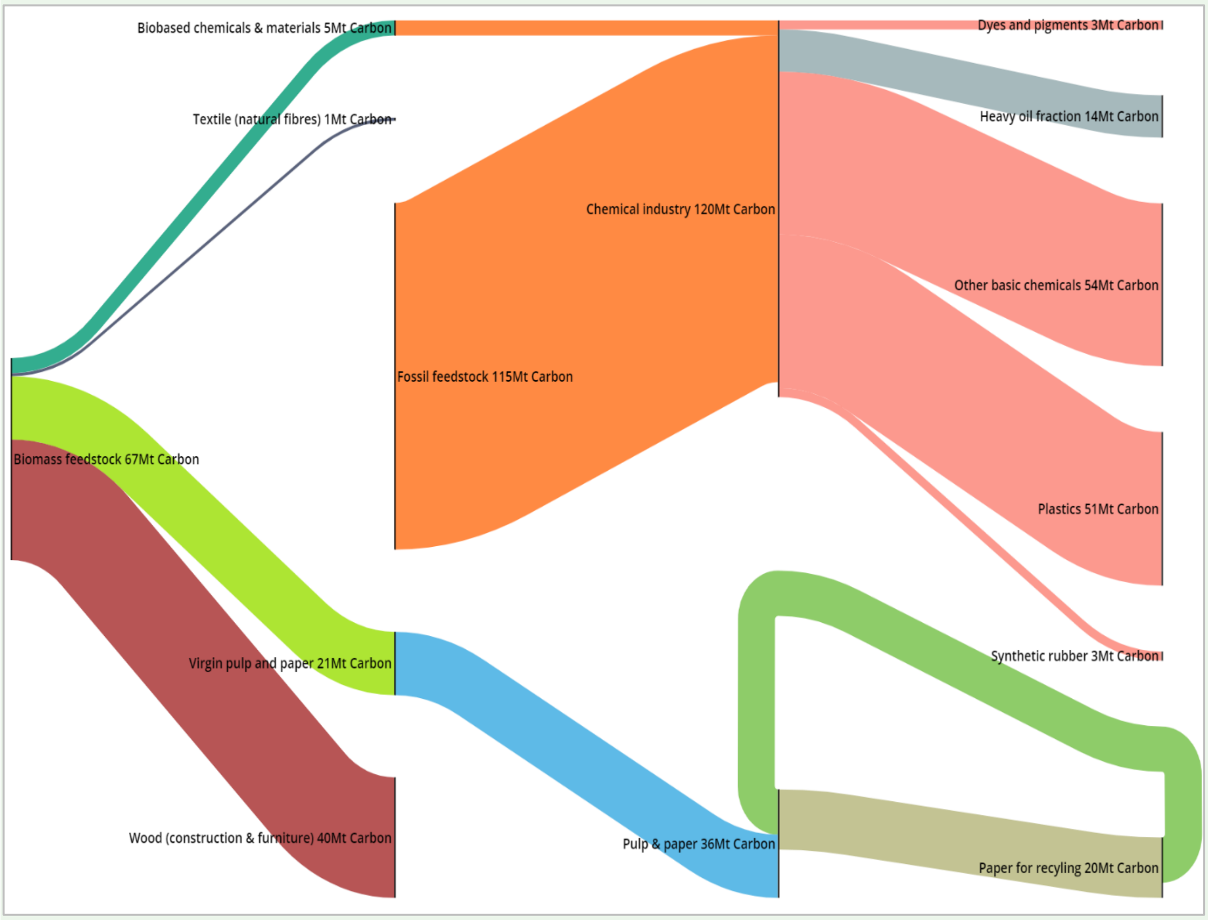
1) Recycling is here mainly understood as virgin demand reduction, not as a supply option. 3% are the biogenic part only.
2) Sum is below 100%, because there are also shares for "circular economy in major value chains" and different kinds of stream cracking (with and without CCS).

Biogenic carbon flows in the pulp and paper sector are already a reality.

Bio-based chemicals and materials are currently estimated at 5 Mt of carbon, and European pulp and paper companies are developing more and more business related to new bio-based products. Notably, thanks to some 139 biorefineries scattered across Europe.

- The current figure already places ahead of plastic recyclates as a feedstock. By comparison the current biomass feedstock used in the industry is estimated at 66 Mt of carbon.
- To meet a share of 40% of the total demand from the chemical industry, industries based on biomass would have to redirect part of their material flows currently used for energy and continue to increase recycling rates.
- From a regulatory standpoint, this requires a clear differentiation between certifiable biogenic and fossil carbon removals.

Flows of organic carbon in the EU-27 material & chemical sector.



Sources: nova-Institute based on Eurostat NACE class 20.1, Eurostat EU-27 energy balance 2018, JRC biomass flows 2020, Mantau 2012, Cepi 2020, Plastics Europe 2022.