

Circular Bioeconomy: Closing Carbon Cycles in Chemical Industries

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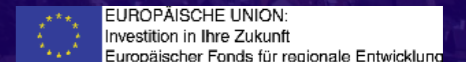
May 13th, 2022



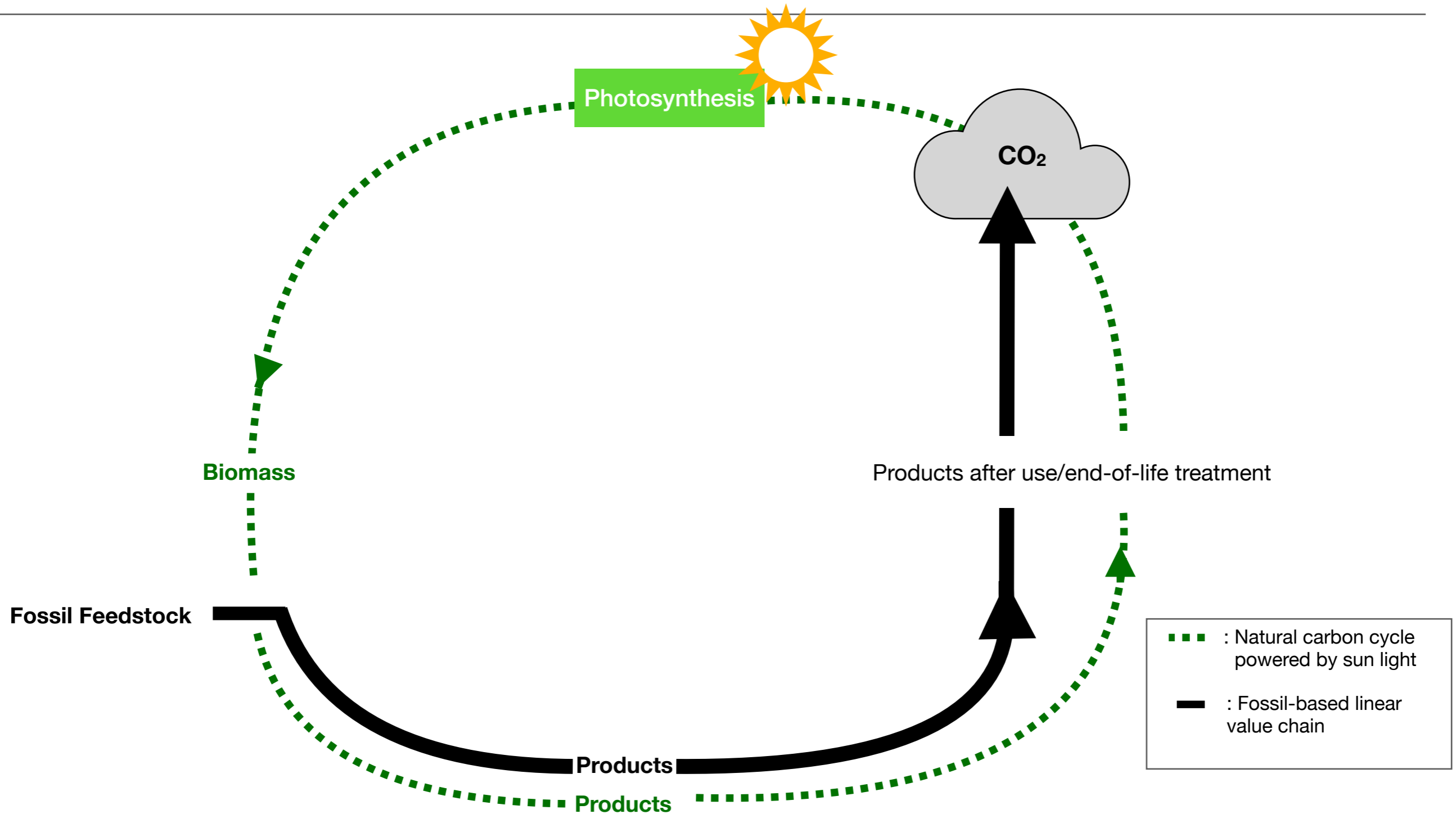
**Process⁴
Sustainability**

Cluster for climate-neutral
process industries in Hesse

Supported by:



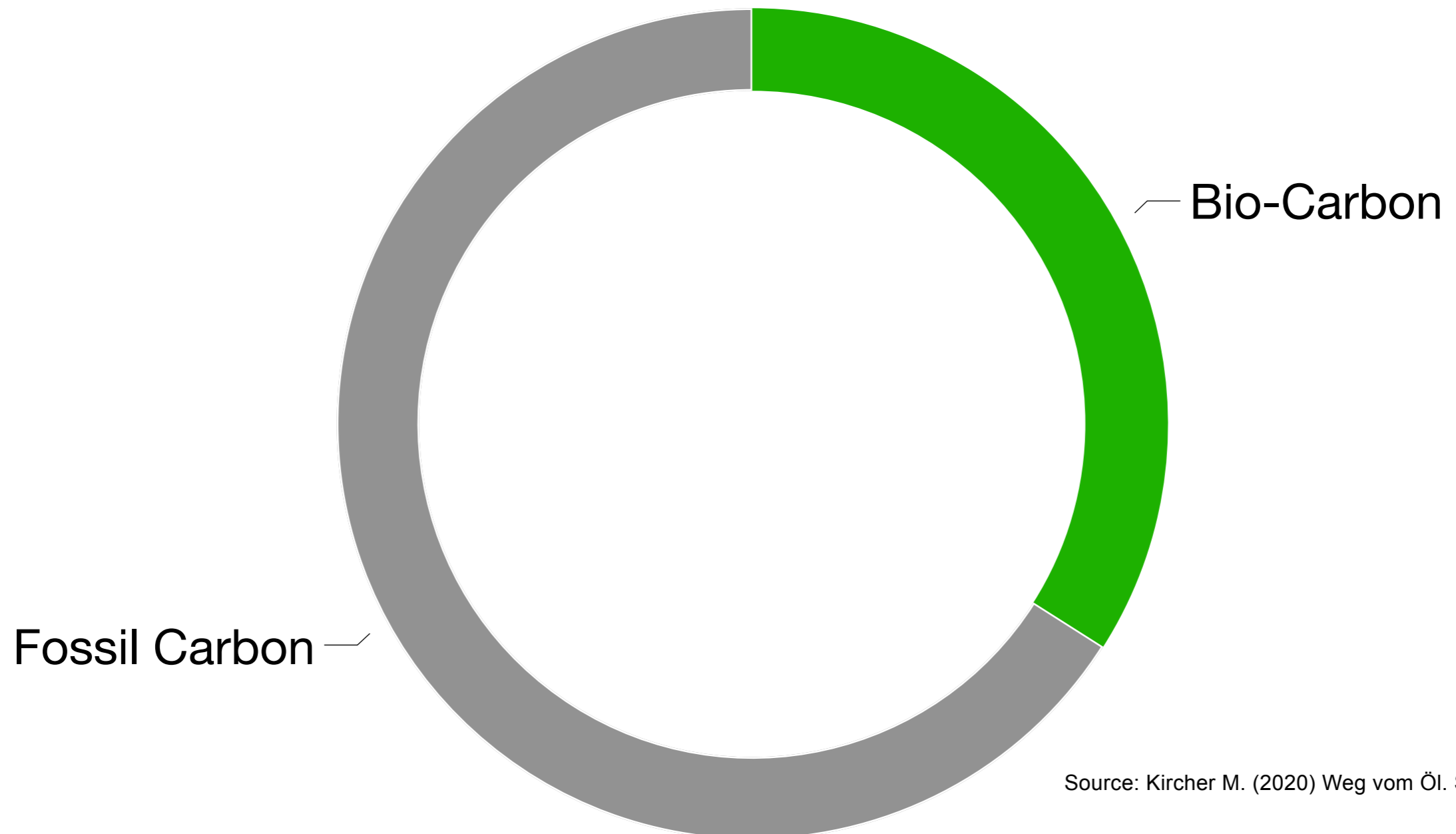
Fossil-based Value Chains are linear, not closed.



Source: Kircher M. (2021) The framework conditions must be aligned to the requirements of the bioeconomy. J. Bioeconomy 11/2021(1) 10003

Globally, we consume twice as much fossil as bio-based carbon.

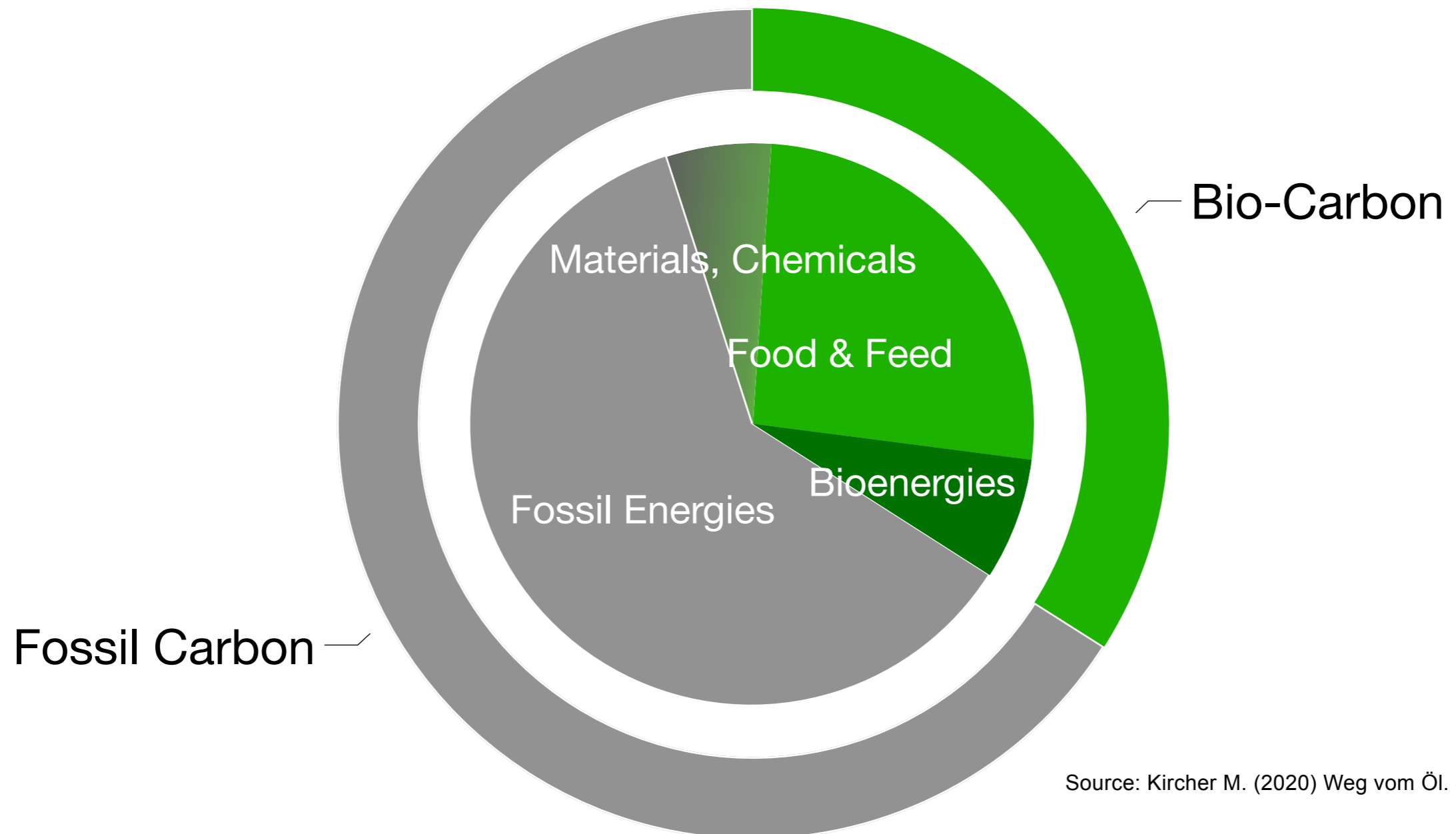
Today's global consumption of fossil and bio-based carbon



Source: Kircher M. (2020) Weg vom Öl. Springer

Biobased Carbon is in food, feed, little in energies and materials/chemicals. Fully replacing fossil carbon is no option.

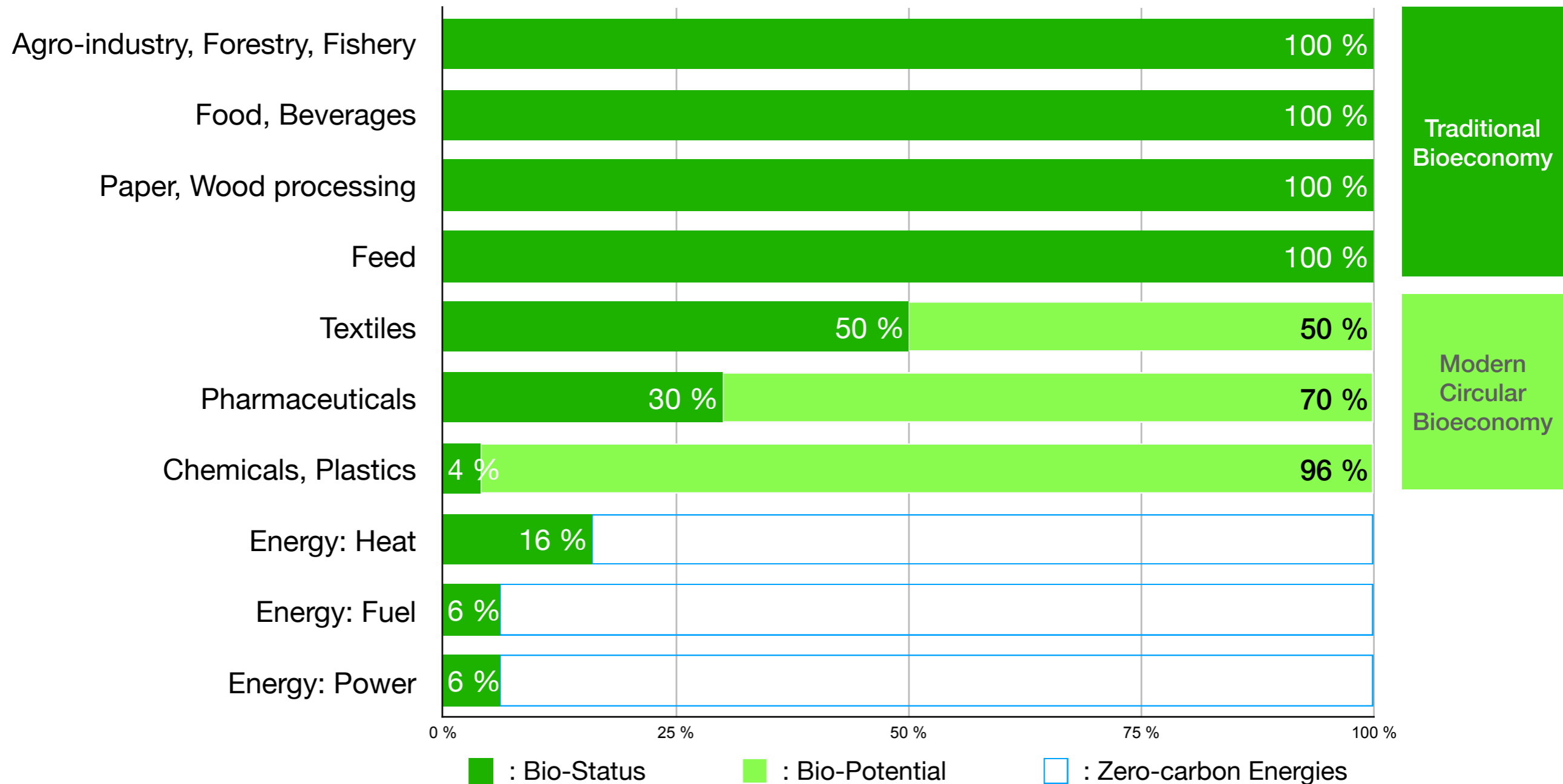
Today's global consumption of fossil and bio-based carbon



Source: Kircher M. (2020) Weg vom Öl. Springer

The modern Circular Bioeconomy should focus on green Materials and Chemicals.

Share of bio-based Products

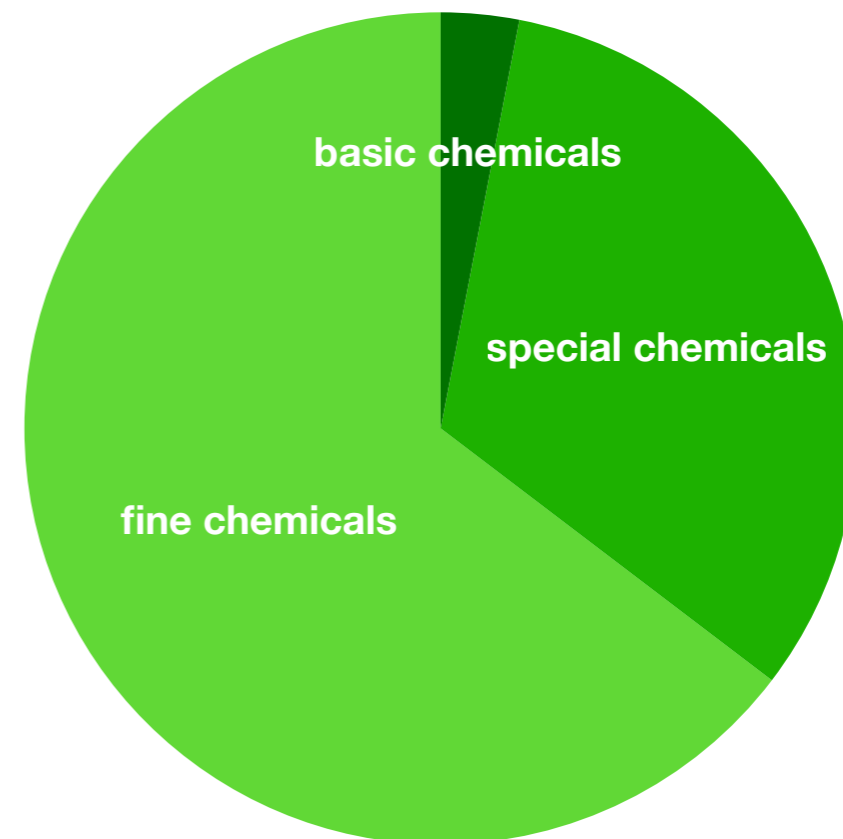


Source: Kircher M. (2020) Bioökonomie im Selbststudium. Unternehmensstrategie und Wirtschaftlichkeit. Springer Spektrum (modifiziert)
FNR (2019) Biobased products and figures

Today, green chemistry is strong in Functionalized Chemicals. In Basic Chemistry the transition has not yet started.

Products	Production (EU, 2016)		
	total	biobased	
	[1000t]	[1000 t]	[%]
Cosmetics	1.263	556	44%
Surfactants	3.500	1.100	31%
Paints, Coatings	882	164	19%
Lubricants	3.900	627	16%
Man-made fibers	5.404	627	12%
Plastics/Polymers	71.000	1.130	2%
Adhesives	8.580	86	1%
Agrochemicals	1.800	0,5	0,03%
Solvents	5.000	0,5	0,01%
Total	101.329	4.291	4%

Today's distribution of bio-based chemicals



Source: E4tech, Nova-institute, BTG, Dechema (2019) Roadmap for the chemical industry in Europe towards a bioeconomy.

Why is the raw material change not progressing?

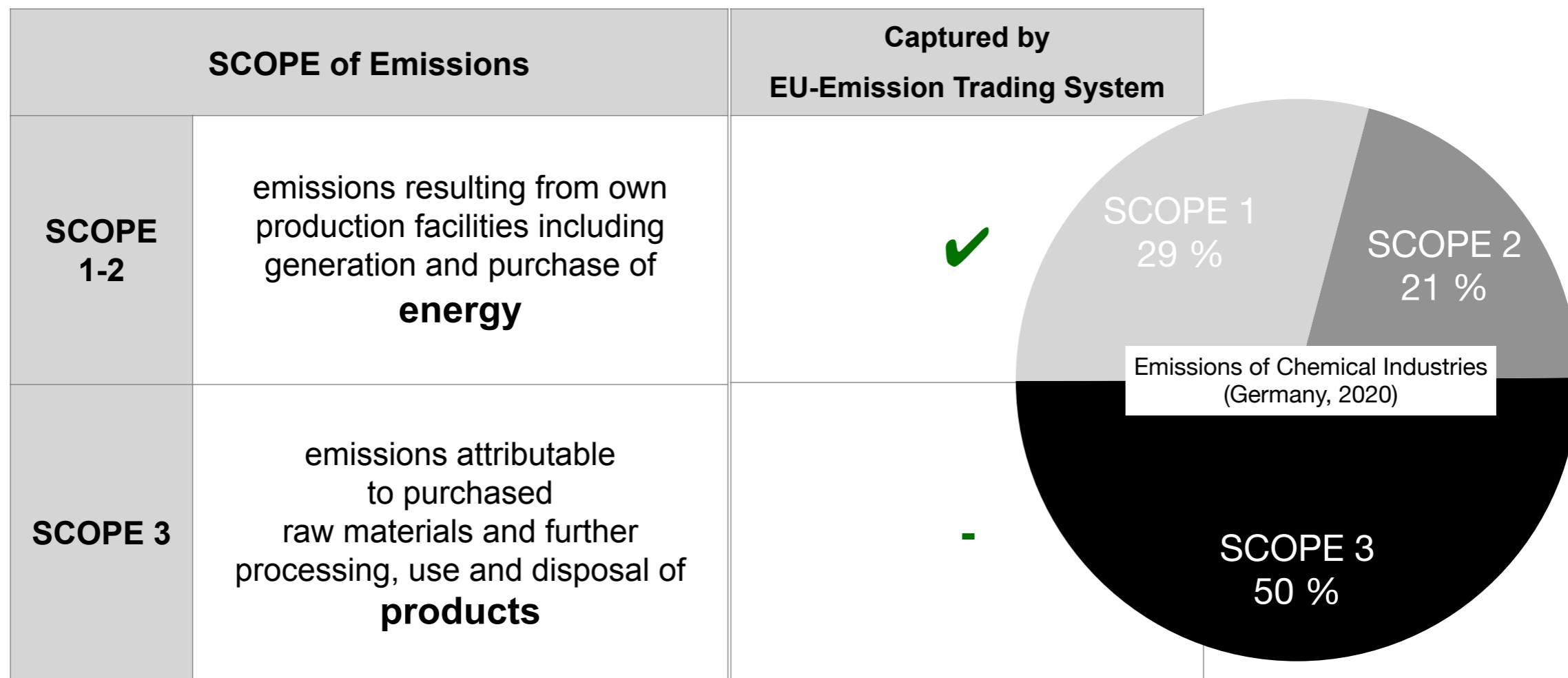
1. Bio-based feedstocks and processes have Pros & Cons.

<i>Green Raw Materials</i>	<i>Pro</i>	<i>Con</i>
part of natural carbon cycle	✓	
driven by solar energy	✓	
wide application spectrum	✓	
functionalized molecules	✓	?
high oxygen load	✓	?
low carbon density		?
complex composition		?
costly logistics		?

<i>Green Processes</i>	<i>Pro</i>	<i>Con</i>
use bio-feedstock	✓	
climate neutral	✓	
high specificity	✓	
broad range of biocatalysts	✓	
low carbon yield		?
limited scalability		?
batch processing		?
costly DSP		?

Why is the raw material change not progressing?

2. EU-ETS charges energy-related emissions.



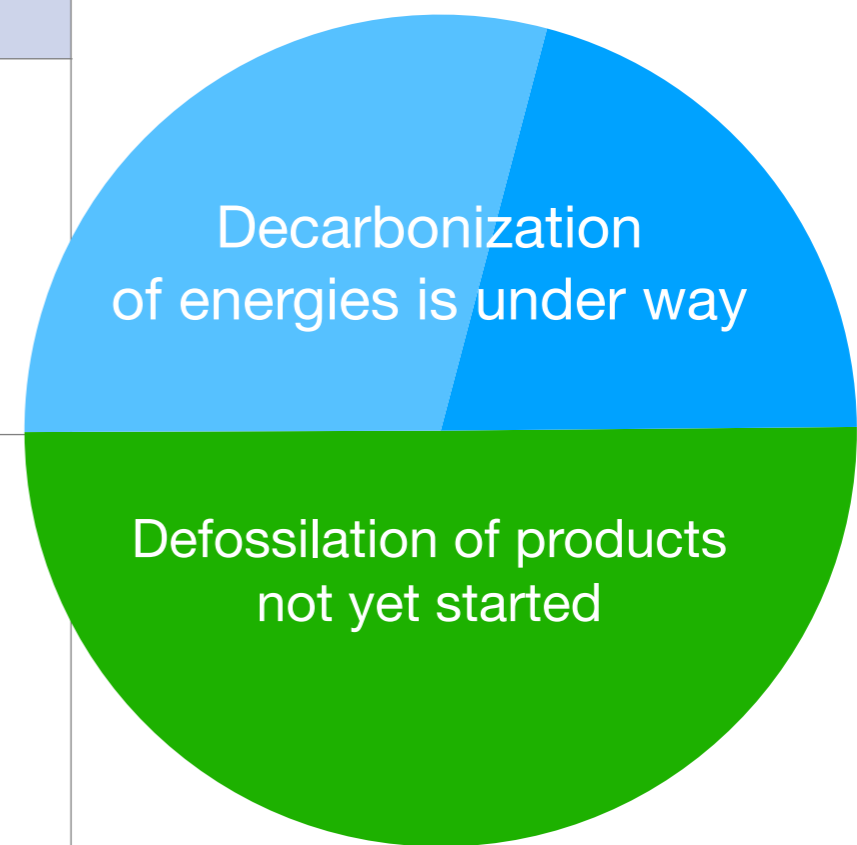
Source: Dechema, FutureCamp (2019) Roadmap Chemie 2050

Kircher, M. (2020) Reducing the emissions Scope 1-3 in the chemical industry. J. Business Chemistry 17 (3); 1-7

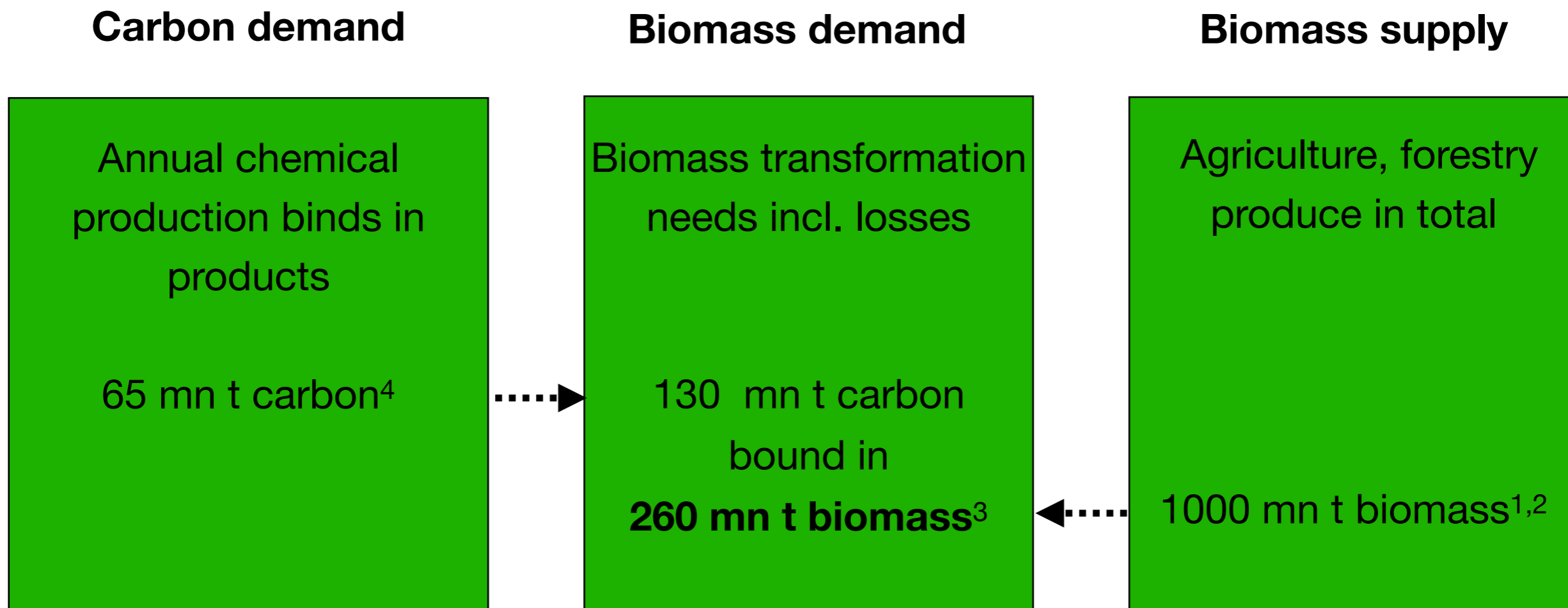
Why is the raw material change not progressing?

2. EU-ETS doesn't push defossilisation of chemicals.

Captured by EU-Emission Trading System		Impact
Energies (scope 1, 2 emissions)	✓	decarbonize energies
Products (scope 3 emissions)	-	-



In the long term, relying on Biomass only would not be sustainable for the Chemical Industry.



1: EU, Agriculture and forestry, 800 million tons harvested + 190 million tons of sustainable residues

2: EC (2018) Biomass production, supply, uses and flows in the European Union. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC109869/jrc109869_biomass_report_final2pdf2.pdf.

BirdLife, Transport & Environment (2016) How much sustainable biomass does Europe have in 2030? <https://www.transportenvironment.org/publications/how-much-sustainable-biomass-does-europe-have-2030>

3: Rough estimation of the materially bound C demand with consideration of the process losses.

4: Boulamanti, A., Moya, J.A. (2017): Energy efficiency and GHG emissions: Prospective scenarios for the Chemical and Petrochemical Industry, JRC Science for Policy Report, p.7,



Organic Waste

(municipals, industry)

1.400.000 t/a WW



Bio-Waste

(green bin, green cuttings)

700.000 t/a WW



Sludges

(municipals, Industry)

146.000 t/a DW

CO₂

CO₂-Emission

(biogas plants)

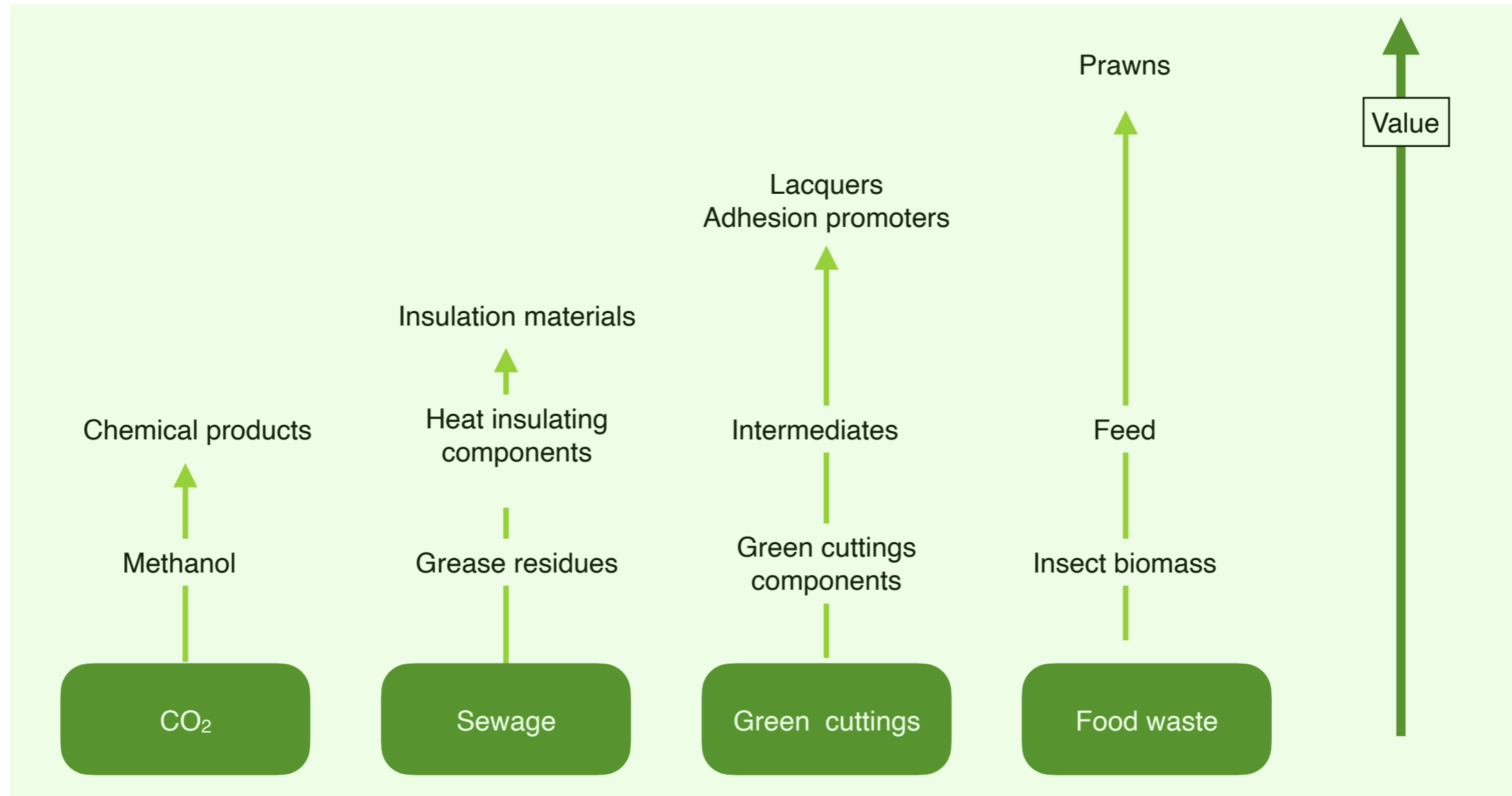
50.000 t/a

Waste volumes in Hesse

Source: Kircher M, Michels J (2015) Studie zur wirtschaftlichen Bedeutung der wissensbasierten Bioökonomie in Hessen. HTal Wiesbaden

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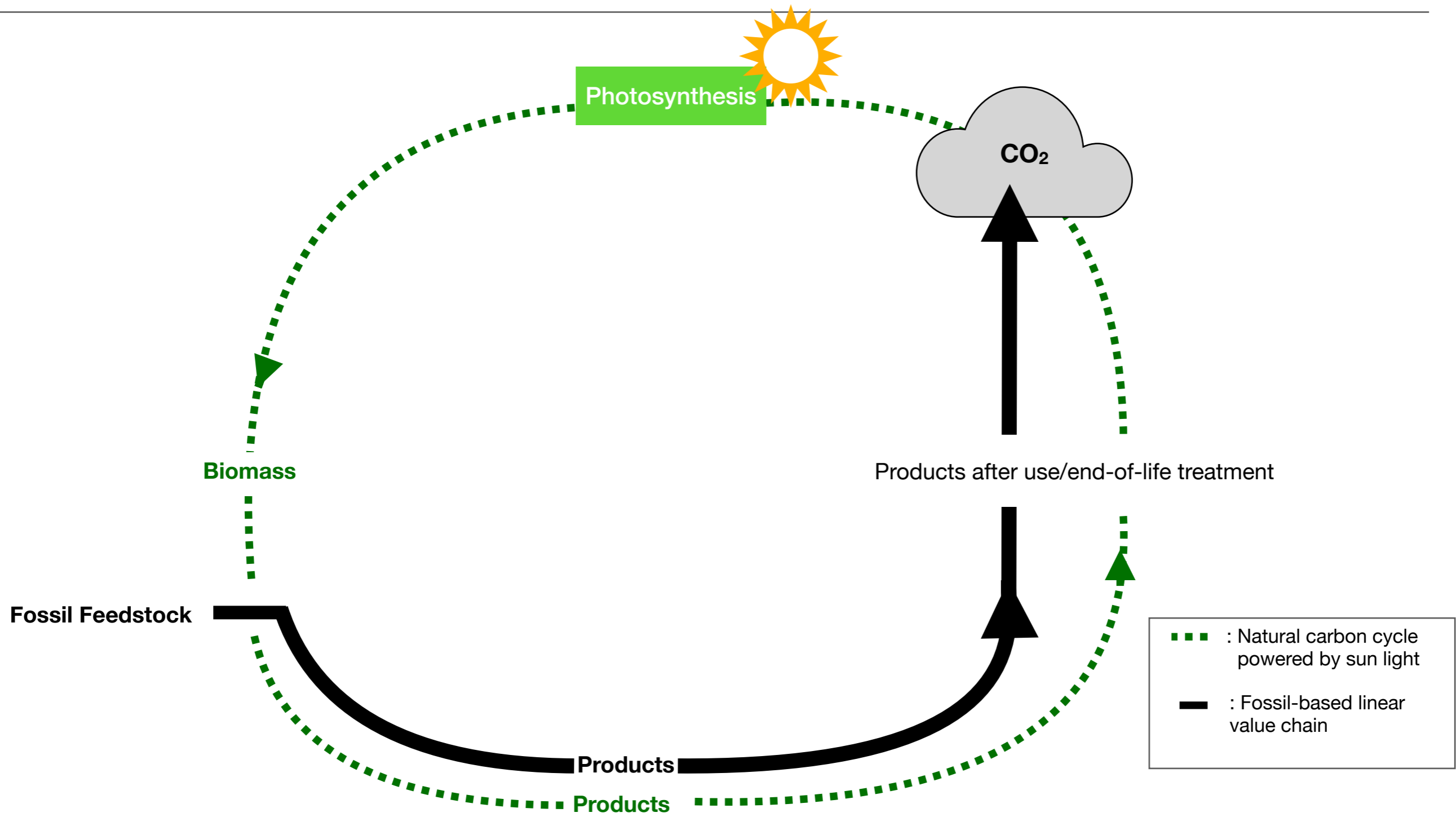
GEFÖRDERT VOM



Running R&D&I projects funded through BioBall by BMBF
 Source: https://biooekonomie-metropolregion.de/bioball/en/home_en.html

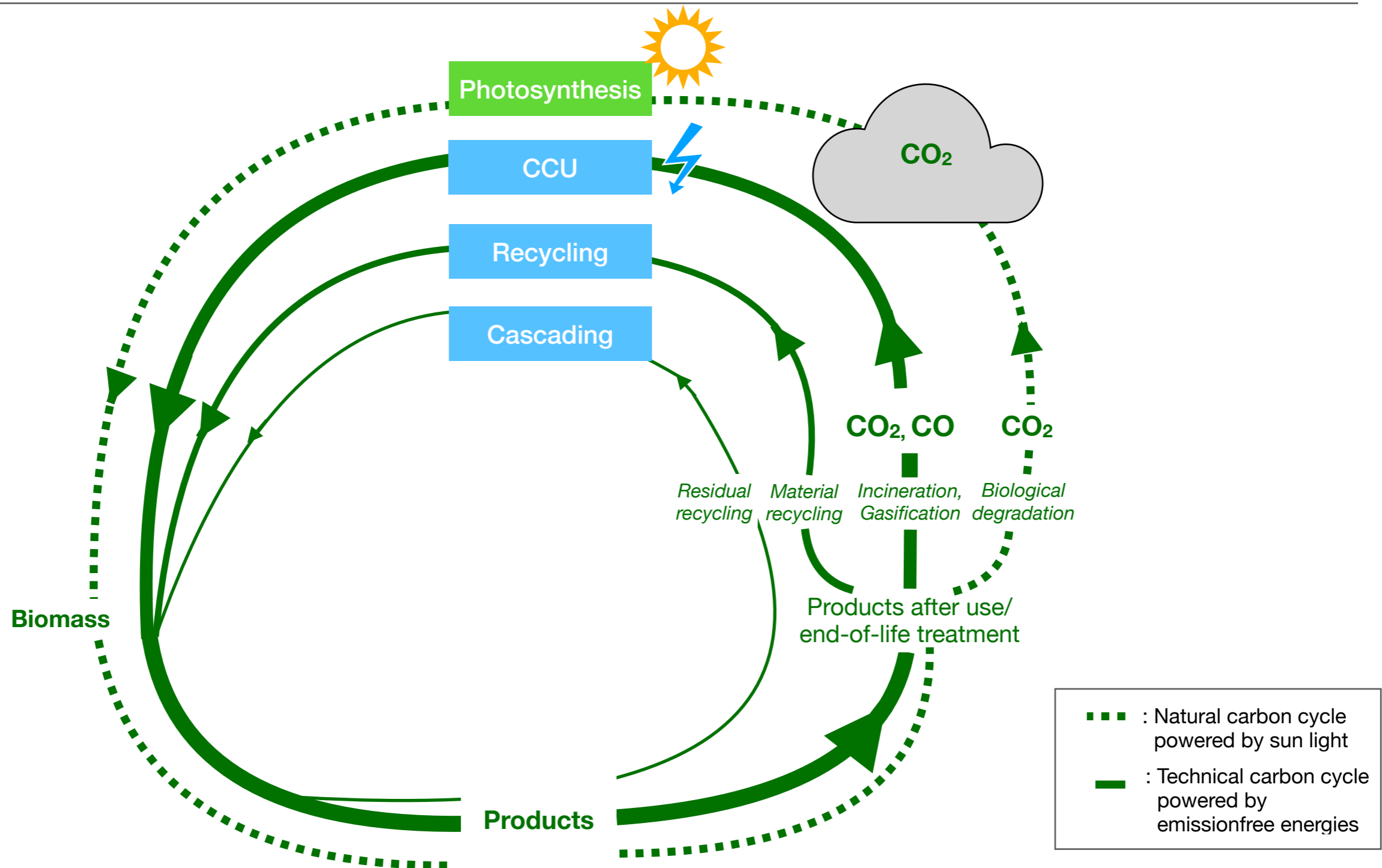
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Currently, Fossil-based Value Chains are linear, not closed.



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The Circular Bioeconomy closes the Carbon Cycle by integrating Natural & Technical Carbon Cycles.



Source: Kircher M. (2021) The framework conditions must be aligned to the requirements of the bioeconomy. Bioeconomy Journal 11/2021(1) 10003

Thank you for your attention!



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