Carbon Flows and Carbon Demand Today and in 2050 – How the Growing Demand can be Covered?

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CARBON ECONOMY – STUDIES ON SUPPORT TO RESEARCH AND INNOVATION POLICY IN THE AREA OF BIO-BASED PRODUCTS AND SERVICES

Carbon economy – Studies on support to research and innovation policy in the area of bio-based products and services

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Nova-Institute, together with COWI and Utrecht University published a report on the role of carbon in the global, European and regional economy for the Directorate-General for Research and Innovation (European Commission).

The report herein contains five Work Packages (WPs) that embody the requirements set out in the European Commission's "Studies on support to R&I policy in the area of bio-based products and services – Carbon Economy (Lot 1)." The main aim of the project was to map out the current pathways available for the transition towards a low carbon economy as well as the barriers that hinder this transition. Based on the conclusions and key findings from the WPs, the authors set the scene for the future of the bio-based sector with a particular focus on ten case studies of regions and cities across the EU (WP4), an evaluation of promising innovations and novel technologies for the realisation of such an economy and a sweeping regulatory analysis containing Q1 2020 updates (WP3) on EU directives and regulations that pertain to the low carbon economy. This attention to the local level as well as the broader policy sphere is supported by a scientific understanding of the low carbon economy (WP1), potential future scenarios towards 2050 (WP2) as well as clear dissemination of the findings across the entire study (WP5). In the frame of the study an animated educational video was produced. The final study report contains an executive summary followed by each Work Package in its entirety, which can also be treated as stand-alone reports in their own right.

Further information at: https://op.europa.eu/en/publication-detail/-/publication/8c4de15d-a17d-11eb-b85c-01aa75ed71a1

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LANGUAGE	
FILE TYPE	PDF
DOWNLOADS	82

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TURNING OFF THE TAP FOR FOSSIL CARBON – FUTURE PROSPECTS FOR A GLOBAL CHEMICAL AND DERIVED MATERIAL SECTOR BASED ON RENEWABLE CARBON

Turning off the Tap for Fossil Carbon – Future Prospects for a Global Chemical and Derived Material Sector Based on Renewable Carbon

FREE

New study on the feedstock for global chemical and derived material sector and future prospects for the transition from fossil to renewable carbon sources

In a new study, total carbon embedded in products from the chemical and derived material sector is examined on a global scale. This includes product groups like plastics, rubbers, textile fibres, detergents and personal care solutions. For the first time ever, total global amount of embedded carbon is calculated, visualized and connected to the different feedstocks. Furthermore, end-user applications are investigated and depicted. A 2050 scenario is introduced, which outlines future prospects to transition from fossil to renewable carbon sources. Solutions for the highly interconnected chemical industry are illustrated together with supporting policy measures. This report aims to raise awareness of the need for, and the technical, industrial and political feasibility of, the biggest transformation of the chemical and derived material sector since the industrial revolution.

AUTHORS	Ferdinand Kähler, Michael Carus, Olaf Porc and Christopher vom Berg
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This study has been carried out on behalf of Unilever plc.


Products from the Chemical and Derived Material Sector in our Daily Lives
Home
Appliances
Perfumes
Soaps & Detergents
Textiles
Toiletries
Work & Mobility
Car Interiors
Electronics
Luggage
Tyres
Food & Drink
Agrochemicals
Bottles
Food Additives
Food Packaging
Infrastructure & Energy
Construction
Insulation
Solar Panels
Wind Turbines
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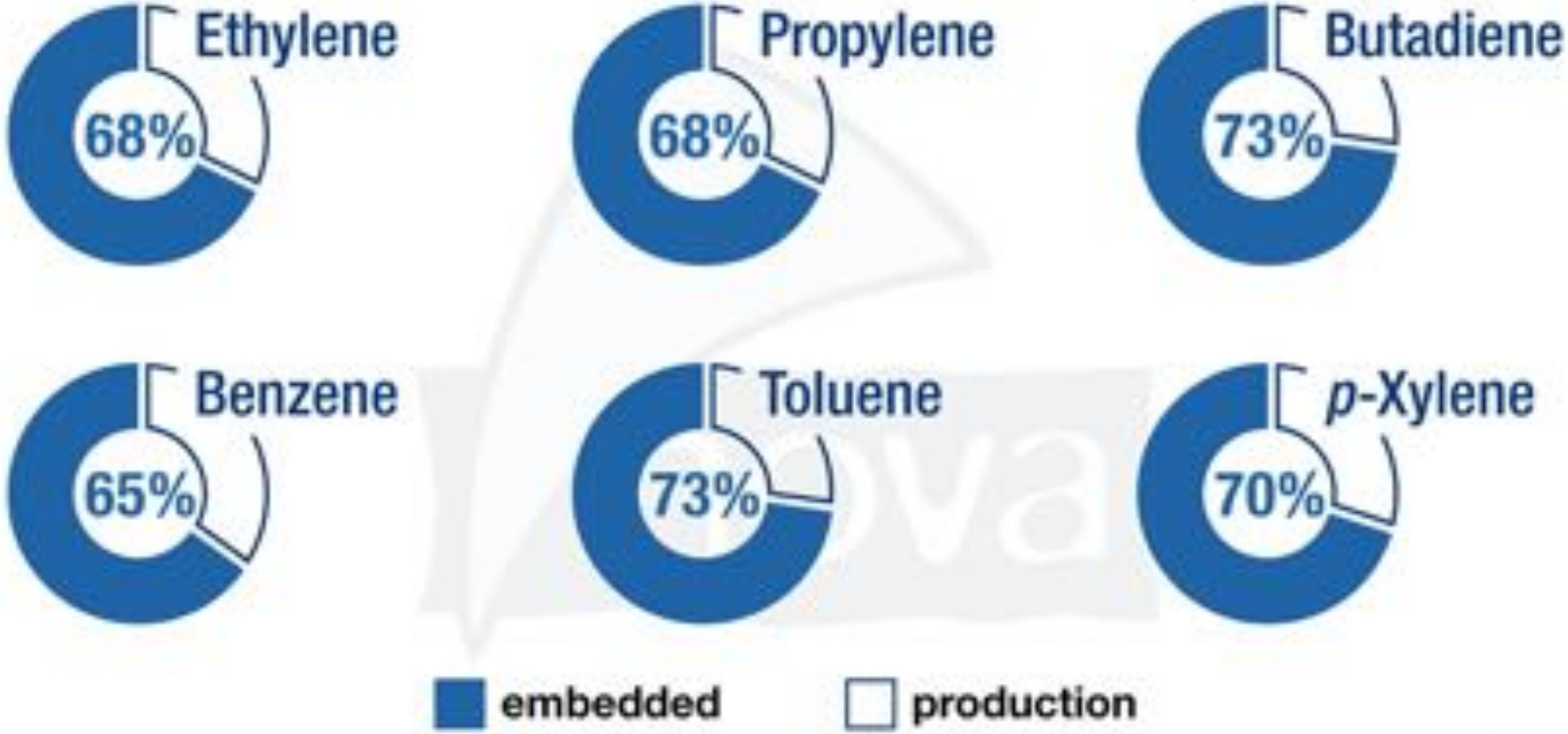
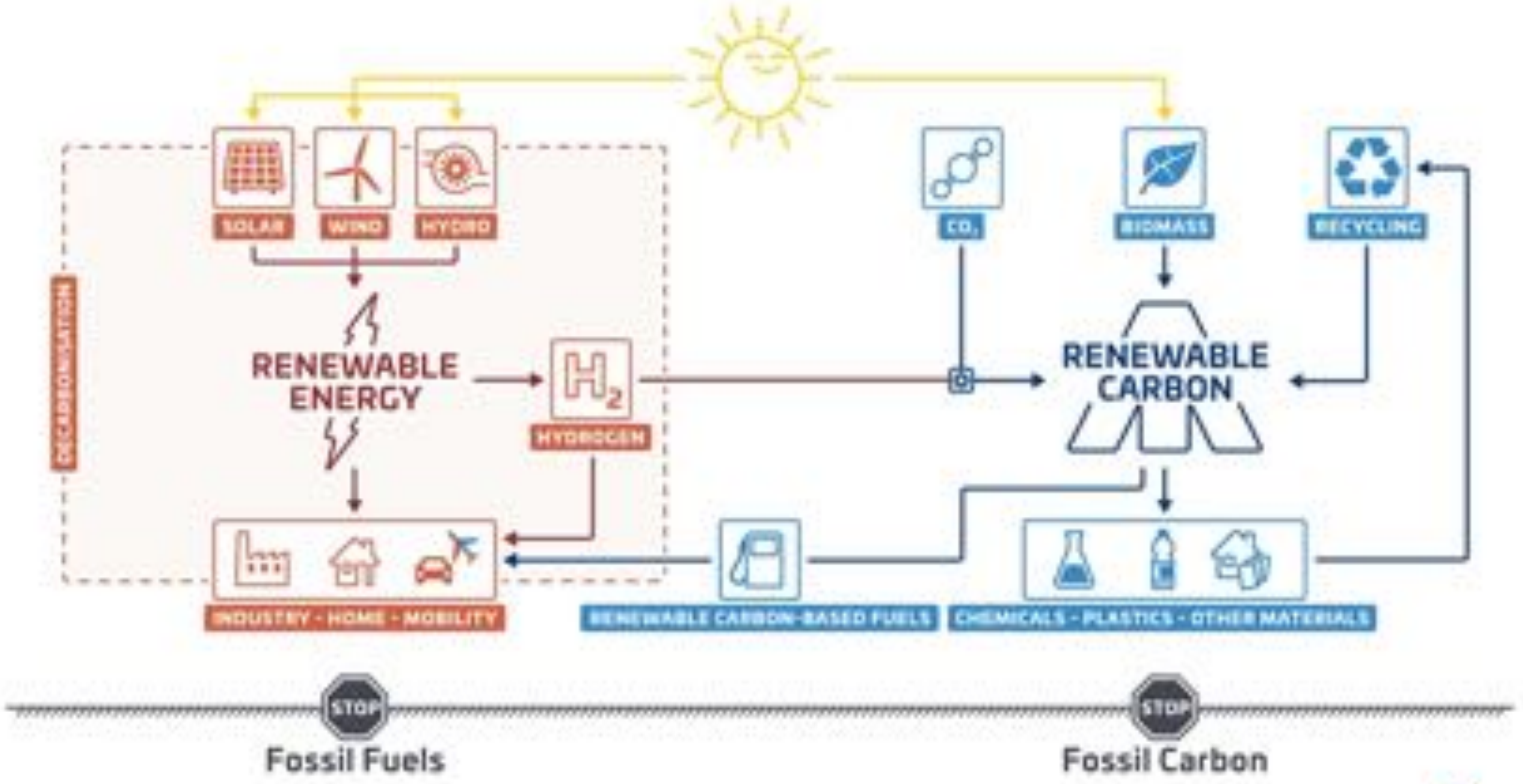
The invisible carbon footprint



Ethylene, propylene, butadiene – Calculations by nova-Institute
Benzene, toluene, p-xylene – Source: BioBTX

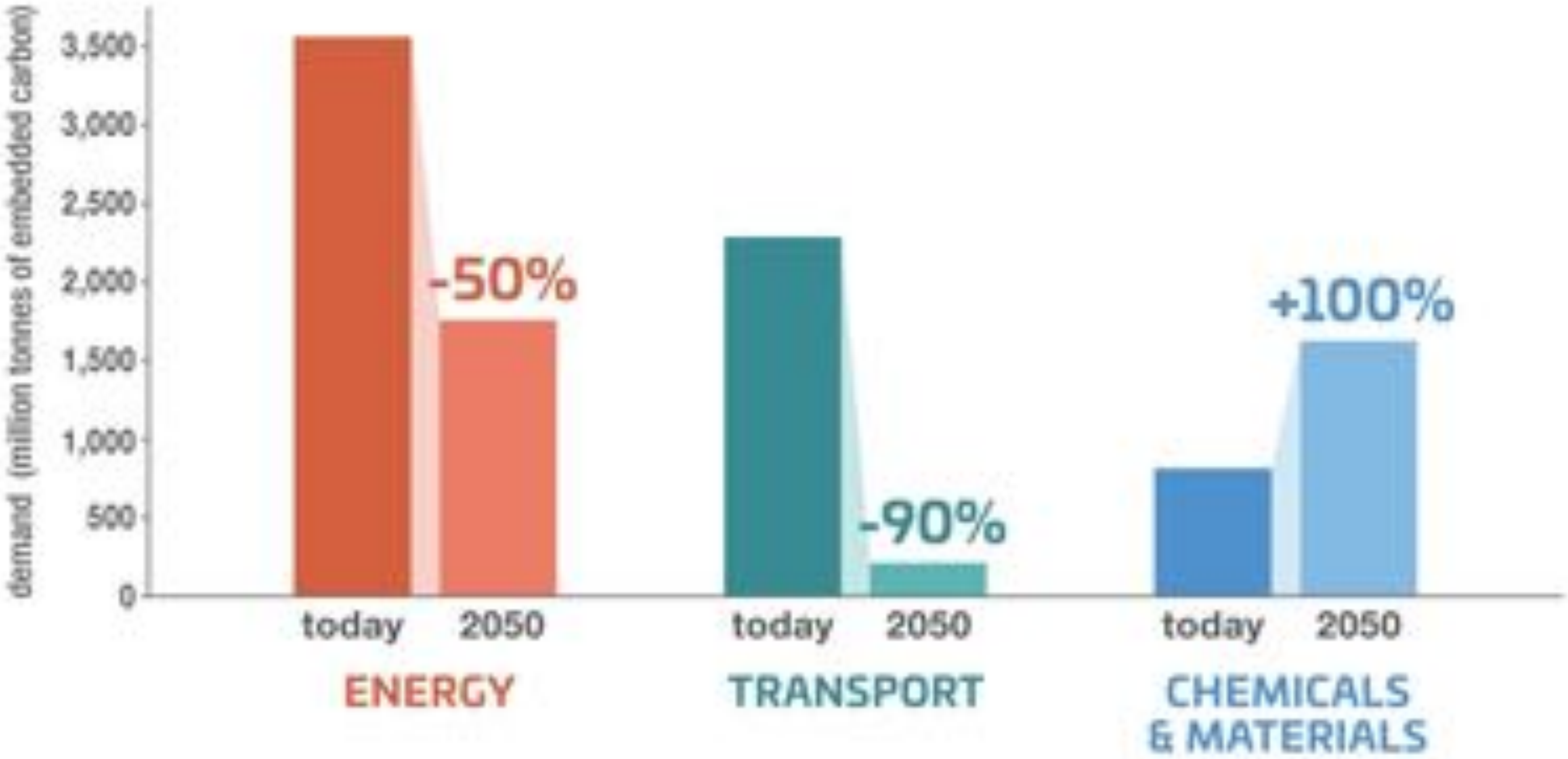
Renewable Energy and Renewable Carbon for a Sustainable Future



All figures available at www.bio-based.eu/graphics

Embedded Carbon Demand for Main Sector

Today (2015–2020) and Scenario for 2050 (in million tonnes of embedded carbon)



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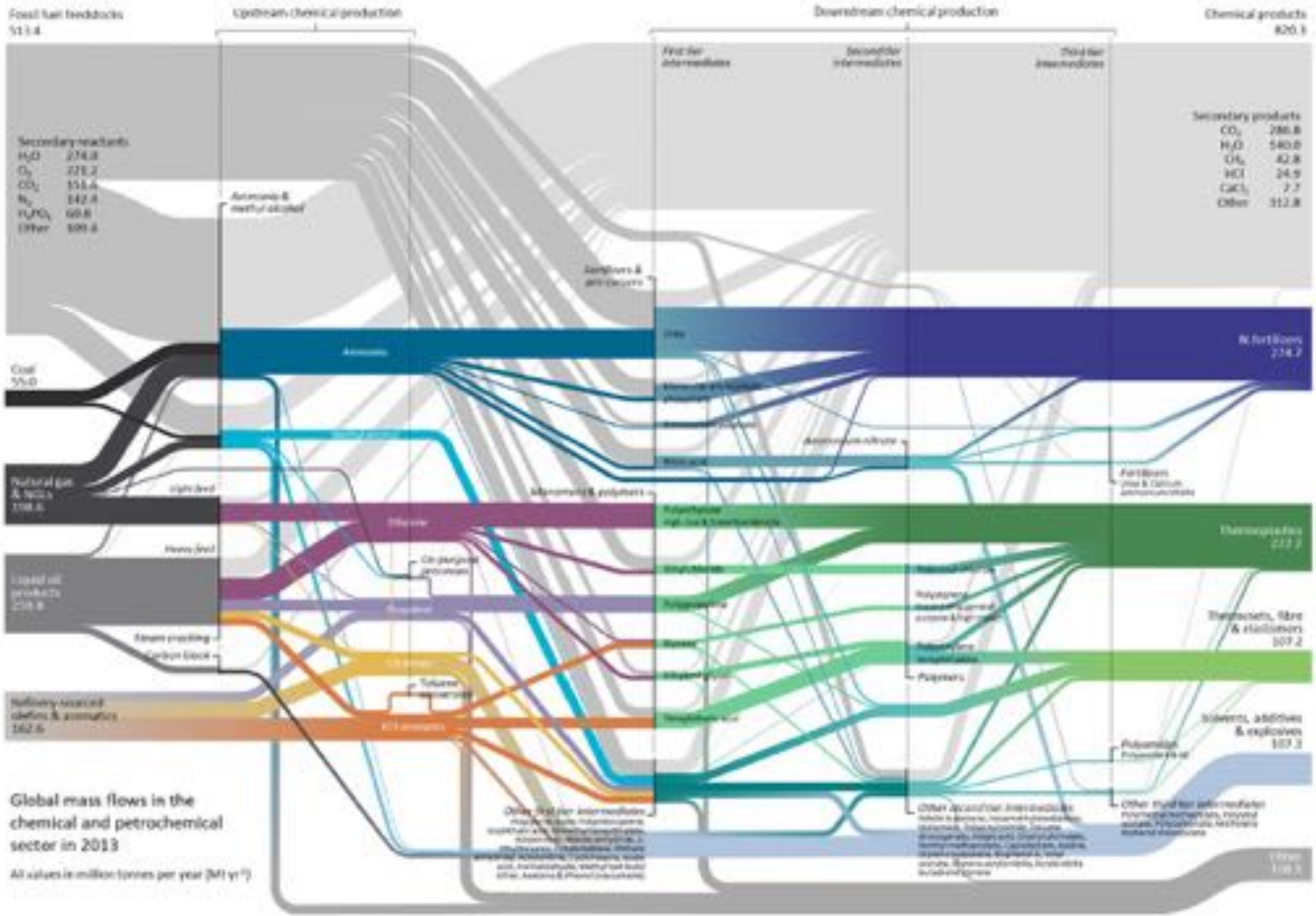
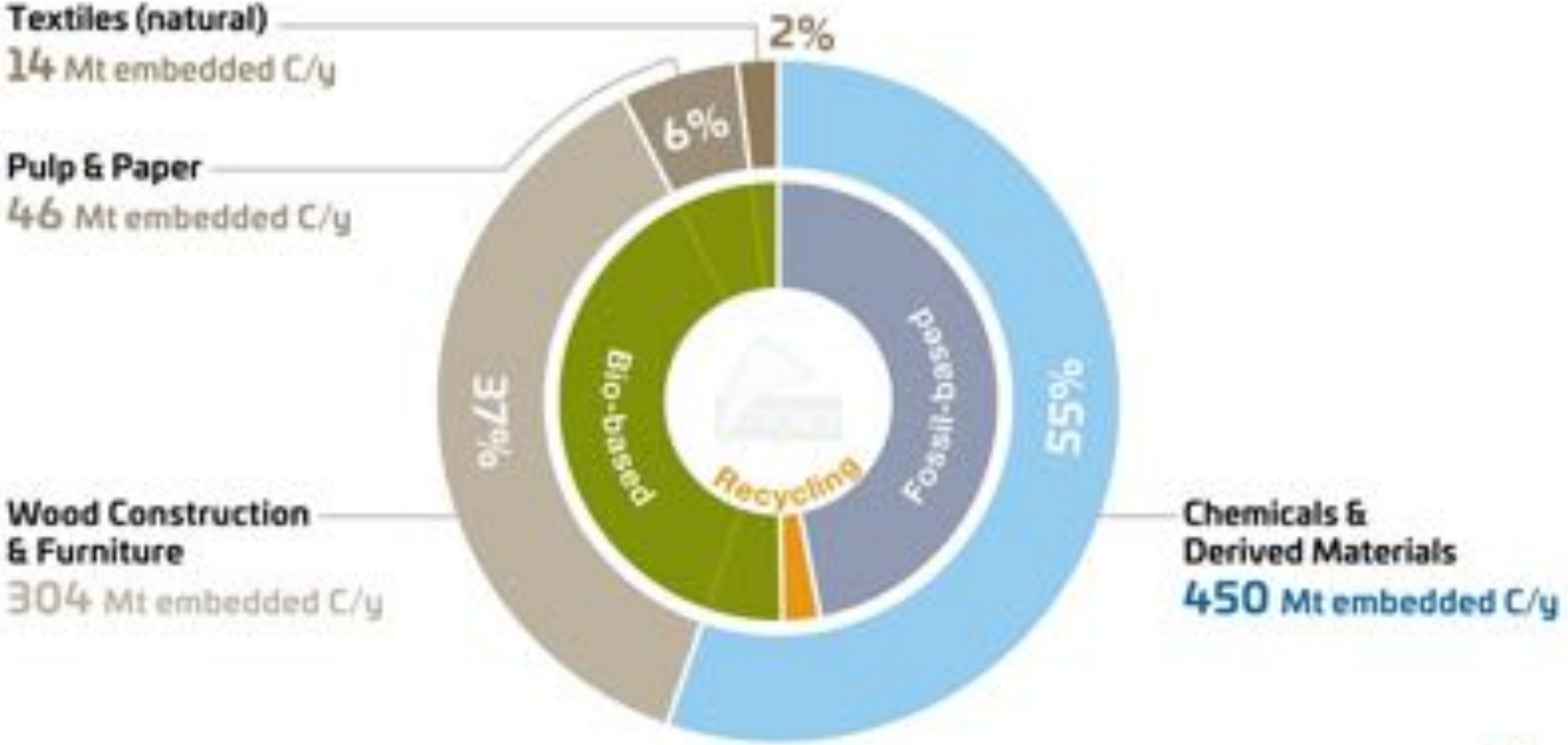


Source: Levi, P. G. and Cullen, J. M. 2018: Mapping Global Flows of Chemicals: From Fossil Fuel Feedstocks to Chemical Products. Environ Sci Technol, Vol. 52 (4), 1725-1734. doi:10.1021/acs.est.7b04573

Global Carbon Demand for Chemicals and Materials by Sectors

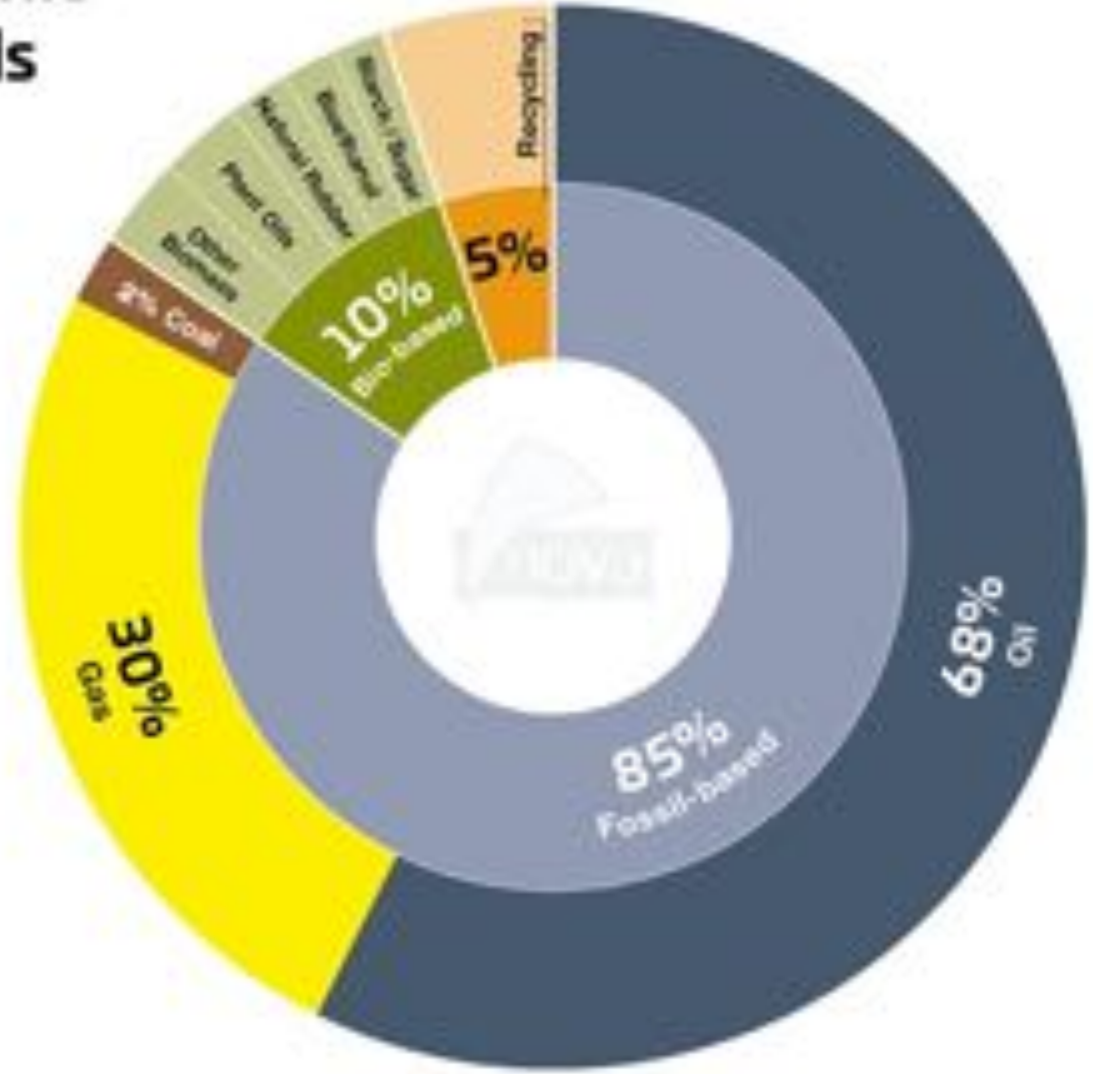
Total: **814 Mt embedded C/yr** – Reference Years: **2015 – 2020**



Global Carbon Demand for Organic Chemicals and Derived Materials

by Type of Feedstock

Total: **450 Mt embedded C/yr**



Reference Years: **2015 – 2020**

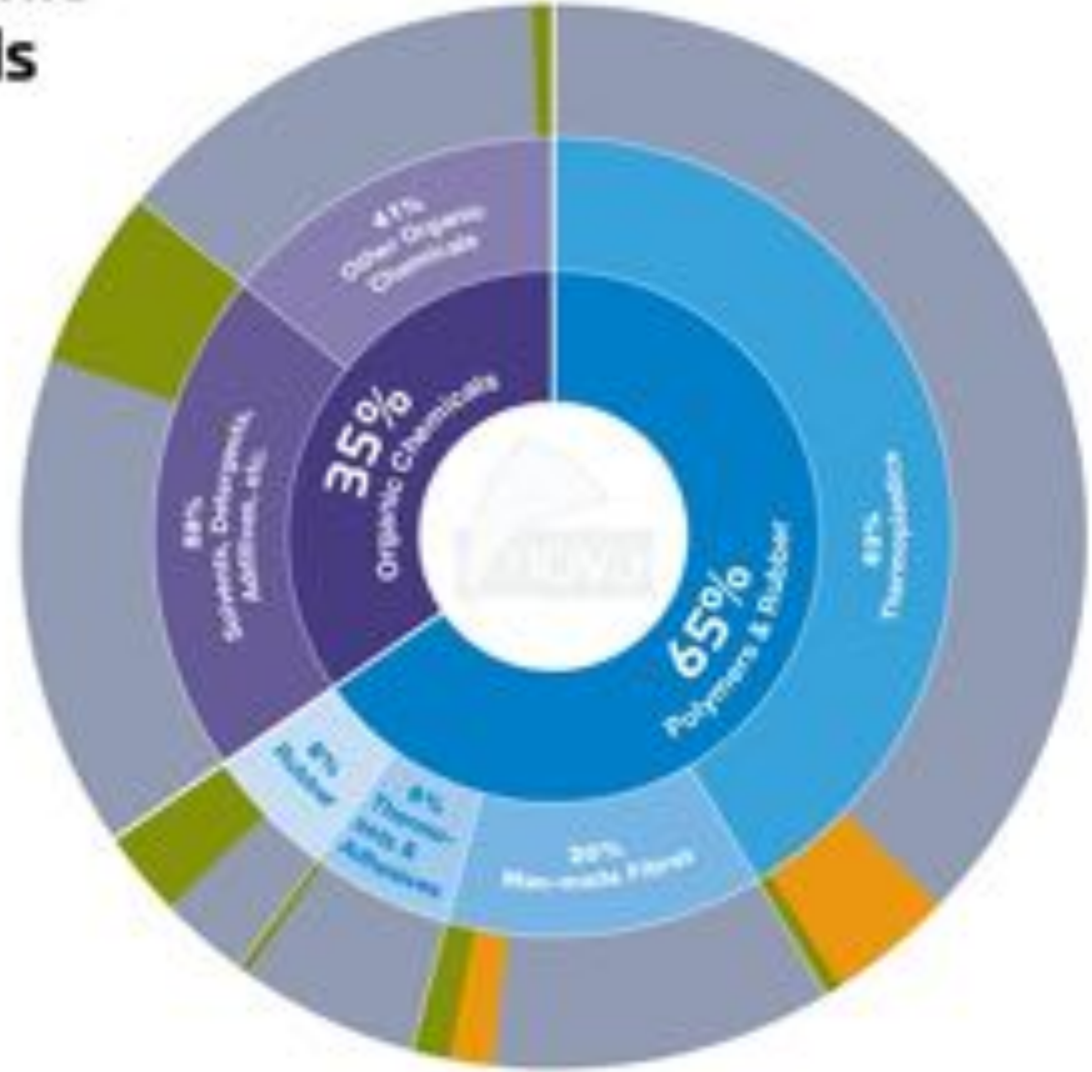
Main Sources: Piotrowski et al. (2015), Hunderfmark et al. (2018), Levi and Cullen (2018), Skoczinski et al. (2021)

available at www.renewable-carbon.eu/graphics

Global Carbon Demand for Organic Chemicals and Derived Materials
by Product Group

Total: **450 Mt embedded C/yr**

- Fossil-based
- Bio-based
- Recycling



Reference Years: **2015 – 2020**

Main Sources: Piotrowski et al. (2015), Hunderlmark et al. (2018), Levi and Cullen (2018), Skoczinski et al. (2021)
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Global Carbon Demand for Organic Chemicals and Derived Materials

by End-user Application

Total: **450 Mt embedded C/yr**

Reference Years: **2015 – 2020**

Main Sources: Geyer et al. (2017), Levi and Cullen (2018), Mordor Intelligence (2019), The Fiber Year Consulting (2020), Skoczinski et al. (2021)

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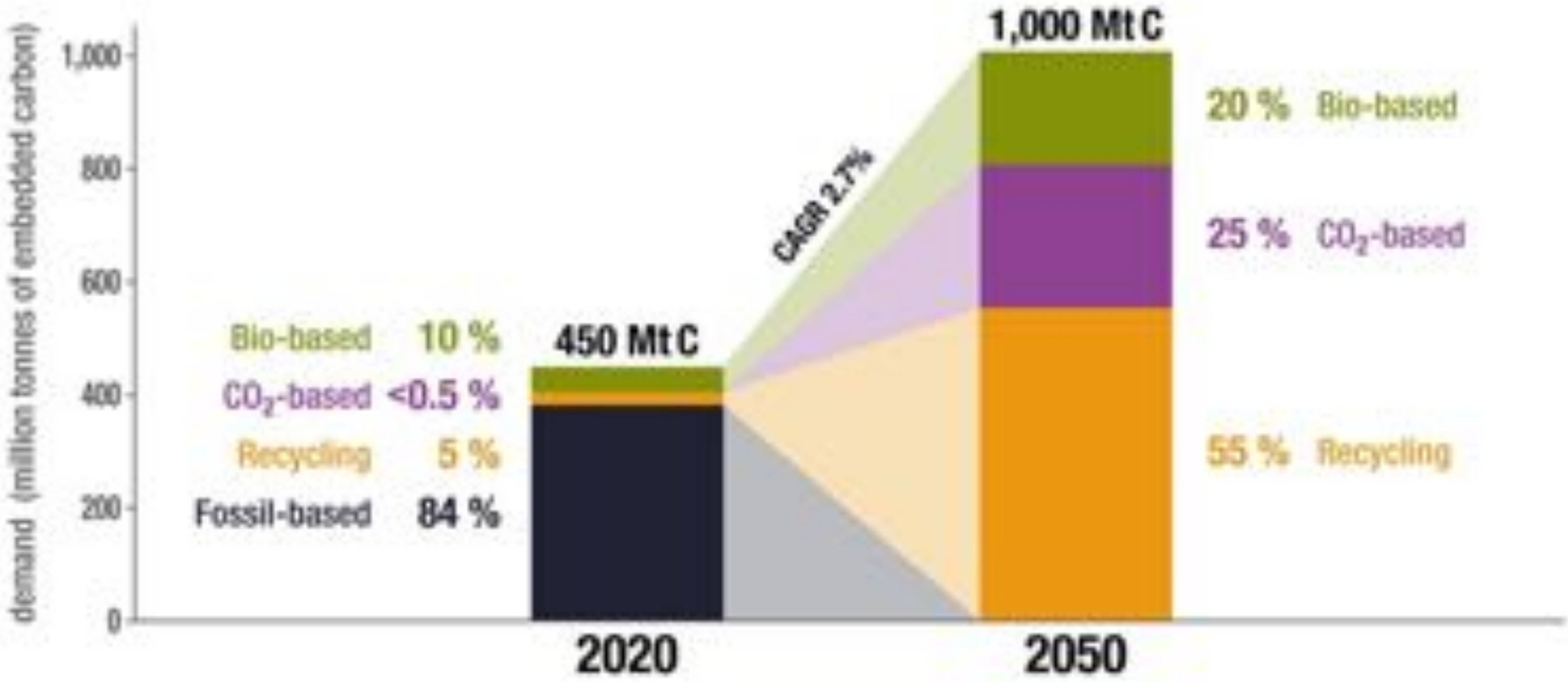
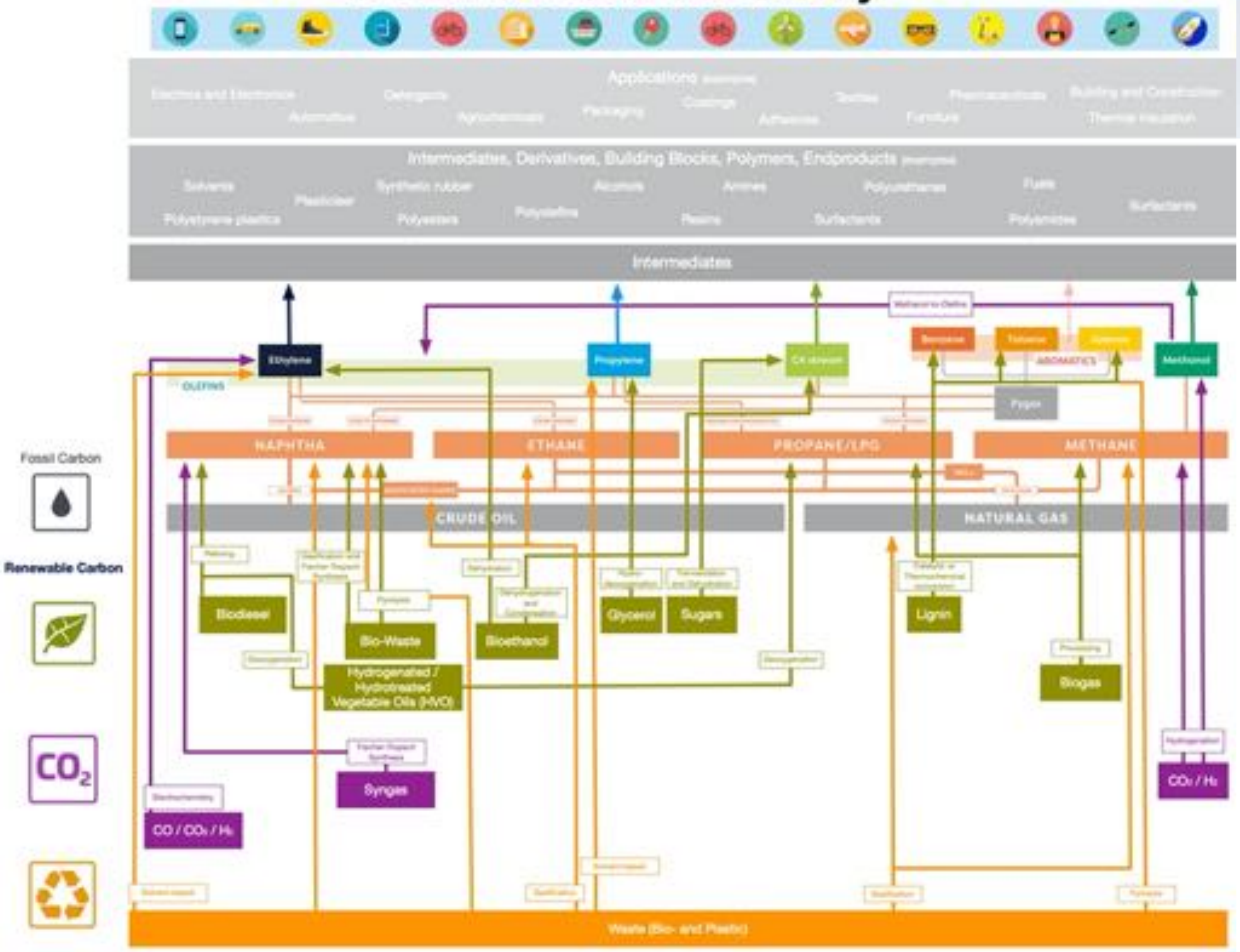
Global Carbon Demand for Chemicals and Derived Materials

in 2020 and Scenario for 2050 (in million tonnes of embedded carbon)



Renewable Carbon Refinery



Source: nova-Institut GmbH, Petrochemicals Europe

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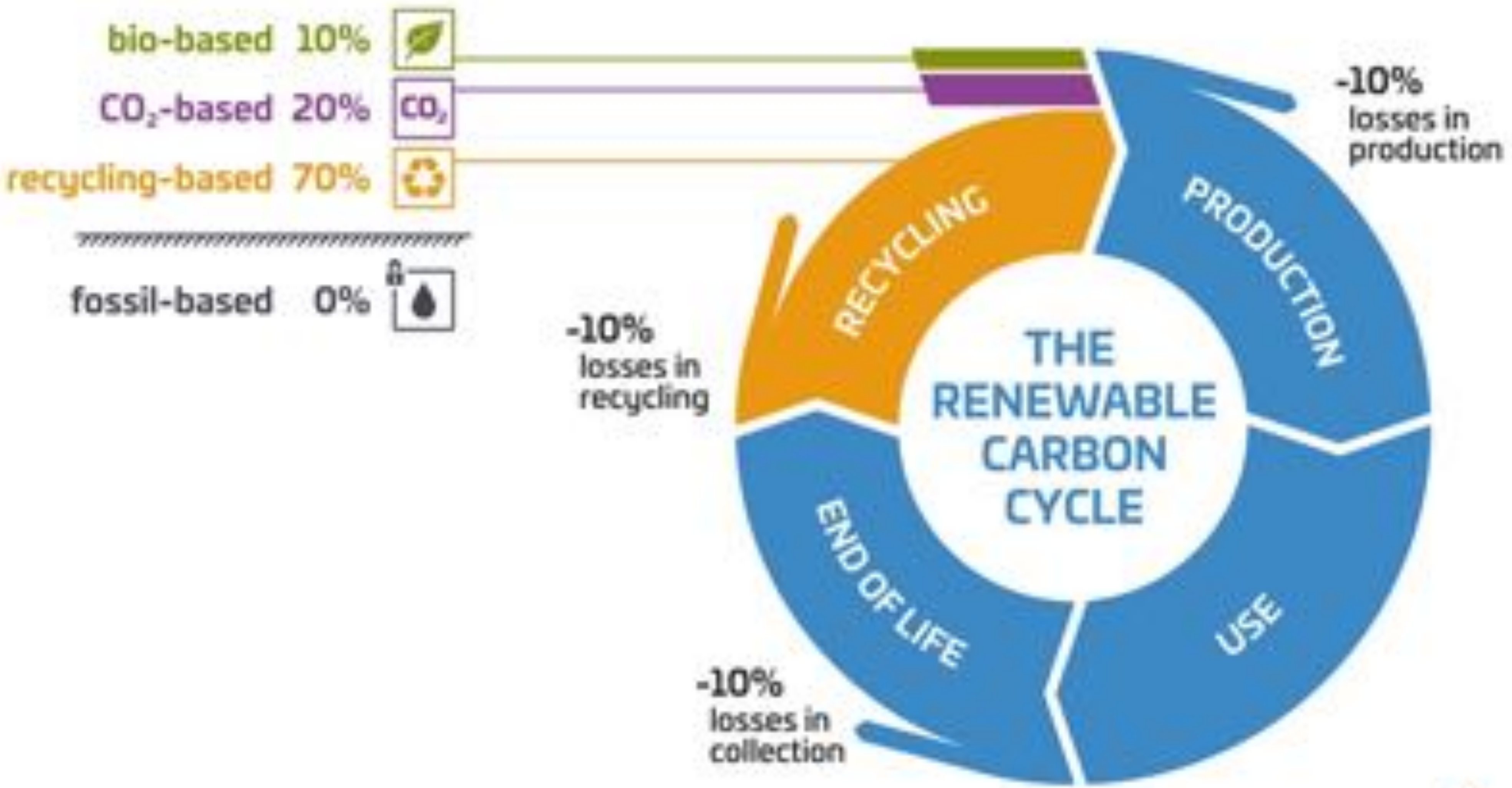
Renewable Carbon: Integration in existing Chemical Structures

SCENARIO FOR THE PLASTIC INDUSTRY 2050



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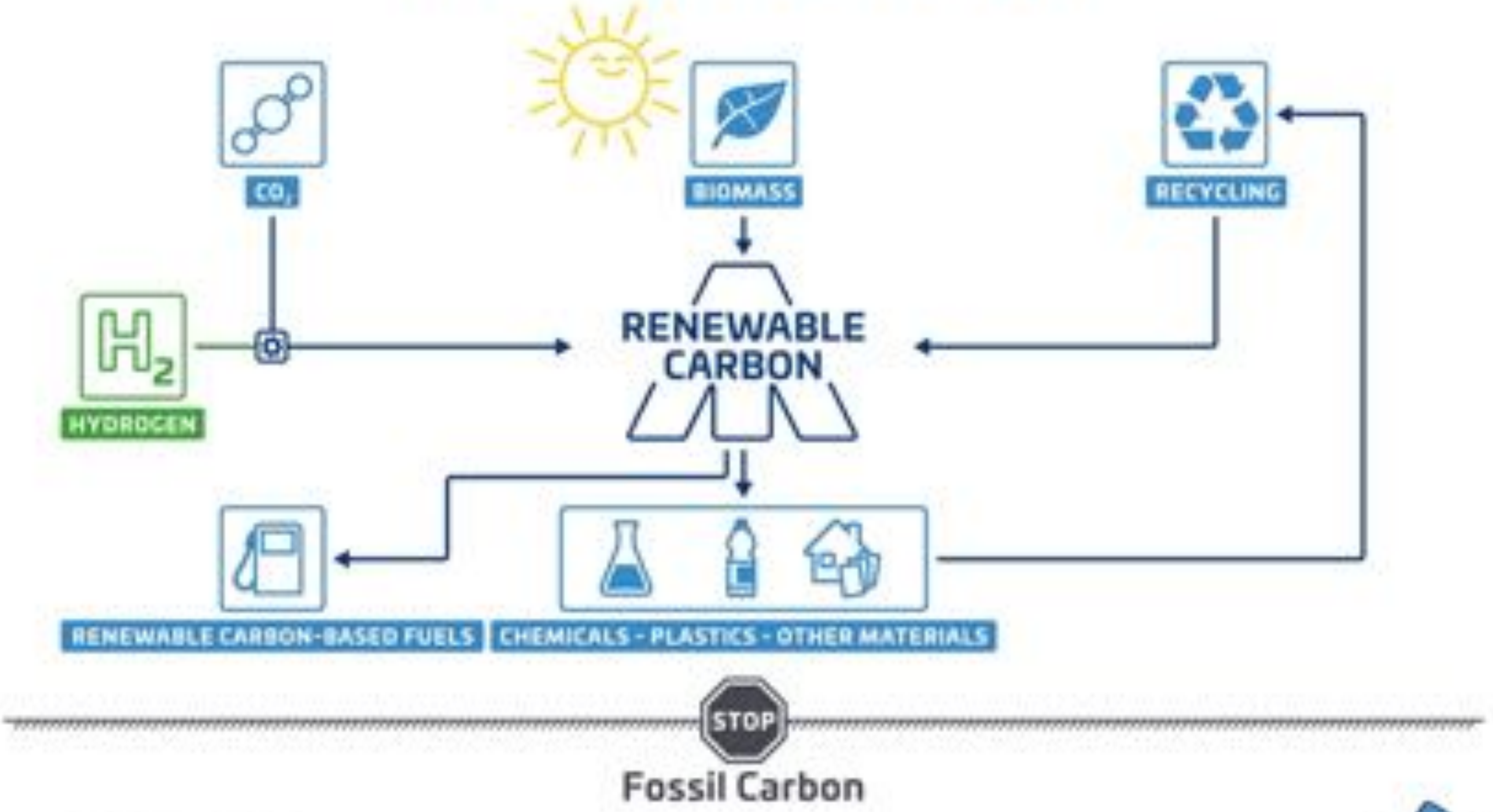
Renewable Carbon



Renewable Carbon from Biomass

Pros in a nutshell

- Food crops:
  - Commodities, established in high volume, good logistics
  - Food crops: Protein-rich by-products
- Wide range of non-food feedstocks – no direct food competition, positive image
  - wood and lignocellulosic by-products and side streams
  - biogenic waste from industry and households
- Low GHG footprint compared with fossil resources
- New green chemical pathways
- Biotechnology as sustainable process technology

Cons in a nutshell

- Limited total volume
- Low land-efficiency
- Potential pressure on land and biodiversity
- Potential competition with food crops and a possible threat to food security

Market trends

High growth areas

- Fine Chemicals CAGR 5-10 %: body care, detergents, cosmetics, pharma
- Bio-based building blocks CAGR 11 %
- Bio-based polymers CAGR 8 % (far above fossil-based with 3–4 %)
- Bio-based Naphtha, high demand
- ... also there is no political support (except R&D), but barriers (SUPD)
- but demand from the brands! (see Renewable Carbon Initiative)

Renewable Carbon from CO_2

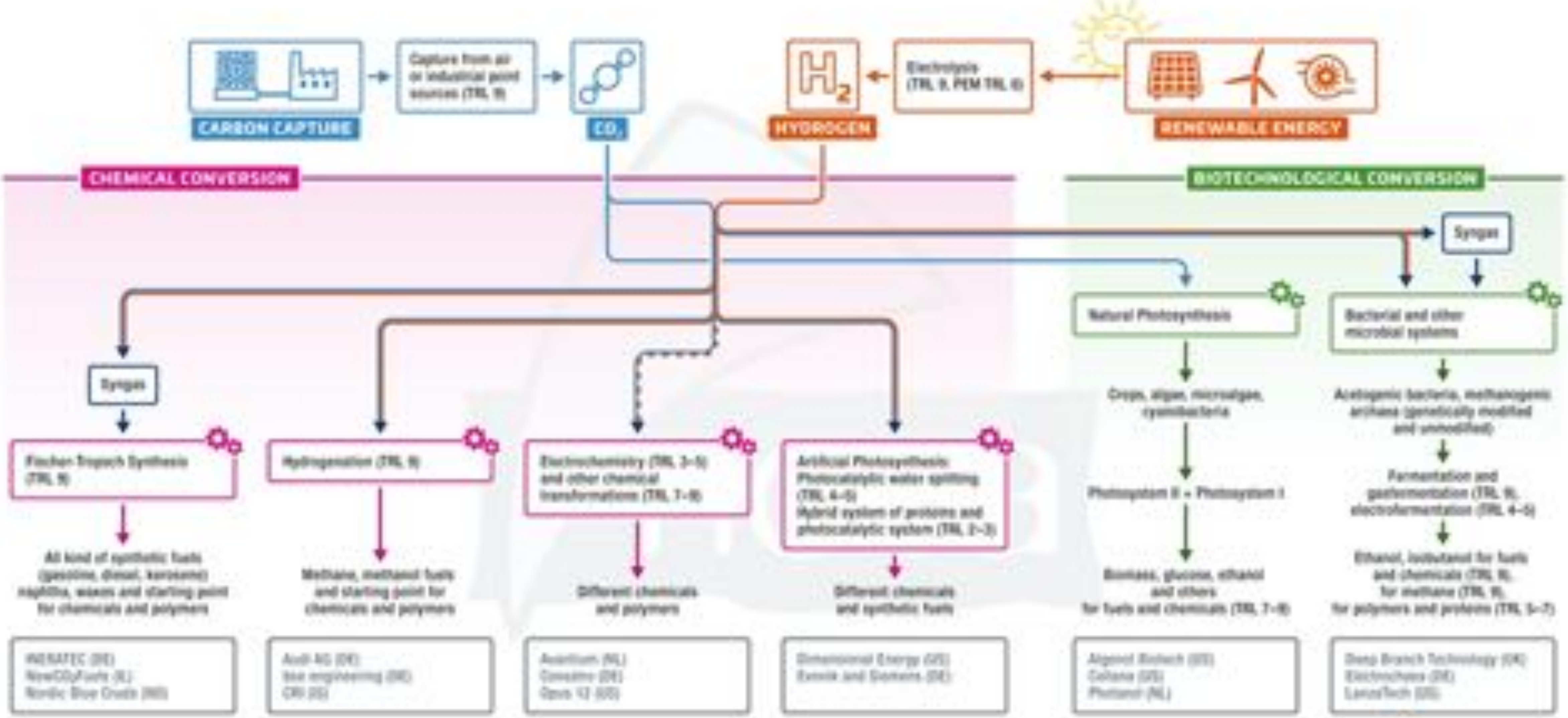
Pros in a nutshell

- Very high potential in volume (almost unlimited)
- Low demand for land and water, low carbon footprint
- High TRL technologies available
- Almost all chemicals and plastics can be produced from CO_2
- High employment potential
- Inexhaustible source of carbon for the next millennia
- Even “black” CO_2 carbon utilisation lead to relevant GHG reduction

Cons in a nutshell

- Potential lock in effects using fossil point sources
- Competition on limited renewable electricity
- High investment necessary

Carbon Dioxide Utilisation and Renewable Energy



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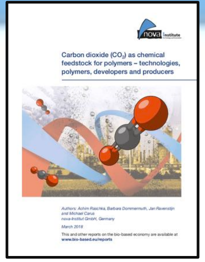
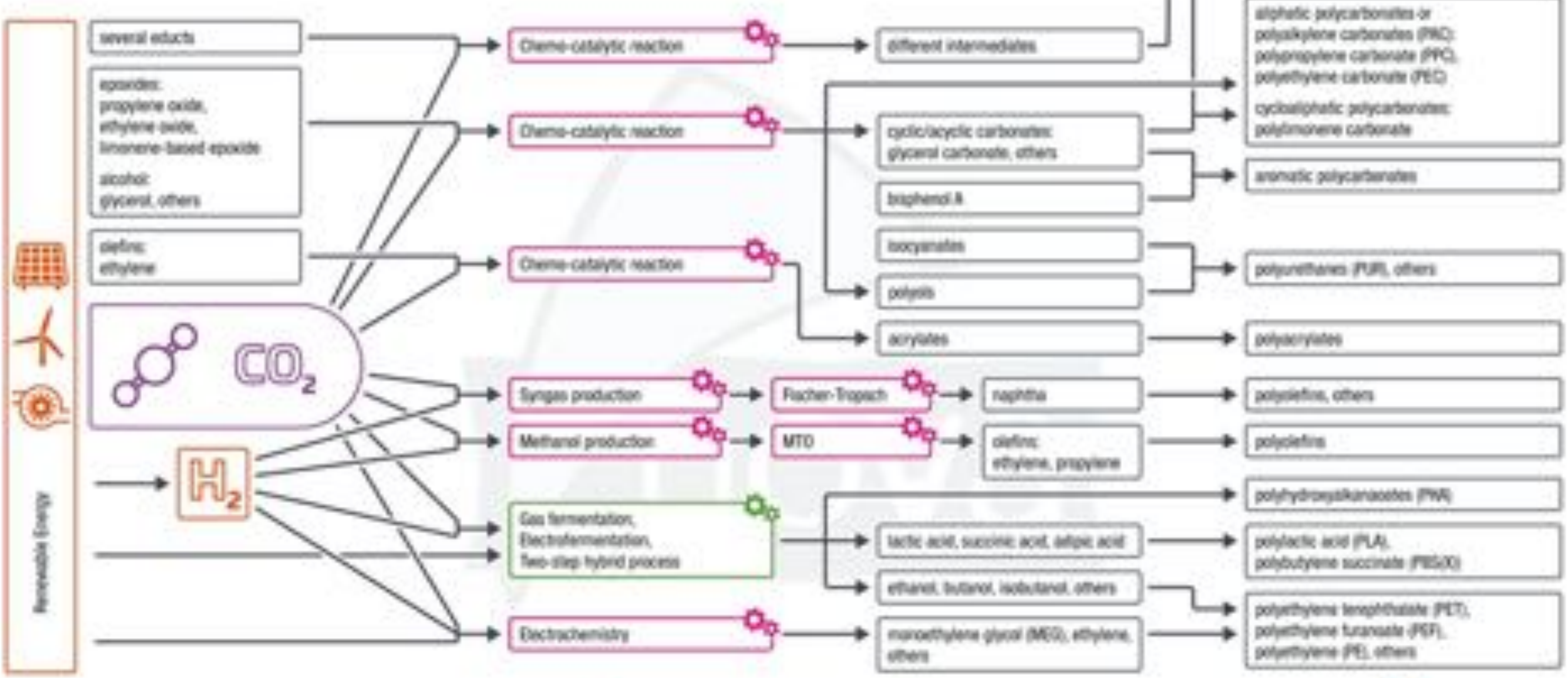
Ways to Use CO_2 for Polymers





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Chemical conversion

Biotechnological conversion

Winners of the Innovation Award

"Best CO_2 Utilisation 2021"

9th Conference on CO_2 – CO_2-based Fuels & Chemicals

Organiser

nova Institute

Innovation Award Sponsor

YNCORIS Industrial Services

Innovation Award Co-Organiser

CO_2 VALUE EUROPE

Carbon Recycling International (IS)
Emissions-to-Liquids Technology

LanzaTech (US)
CarbonSmart Ethanol

Covestro (DE)
Washing with CO_2-Technology – Surfactants based on CO_2

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www.co2-chemistry.eu

Non-energetic demand from the Chemical Industry

Different calculation show that a range of 15 to 20 PWh would be required to cover the entire carbon demand of the chemical industry today by CO_2 utilisation with renewable energy, depending on the efficiency of electrolysis and further processes. **For the production of 20 PWh solar power, only 0.9% of the Sahara region is needed for PV**.

The PV yield in the Sahara is typically about 250 GWh/km^2/y (Breyer 2019, LUT University). That means: To produce 20 PWh from PV an area of 80,000 km^2 is needed. Compared to the total area of the Sahara of 9,200,000 km^2 this is only 0.9% of the Sahara region.

The energy won from this area could cover the global non-energetic carbon demand of the chemical and plastics industry as it was in 2018 when applying it to carbon capture and utilisation (CCU) processes.

The total area of deserts is even 30,000,000 km^2.

Renewable Carbon from Recycling

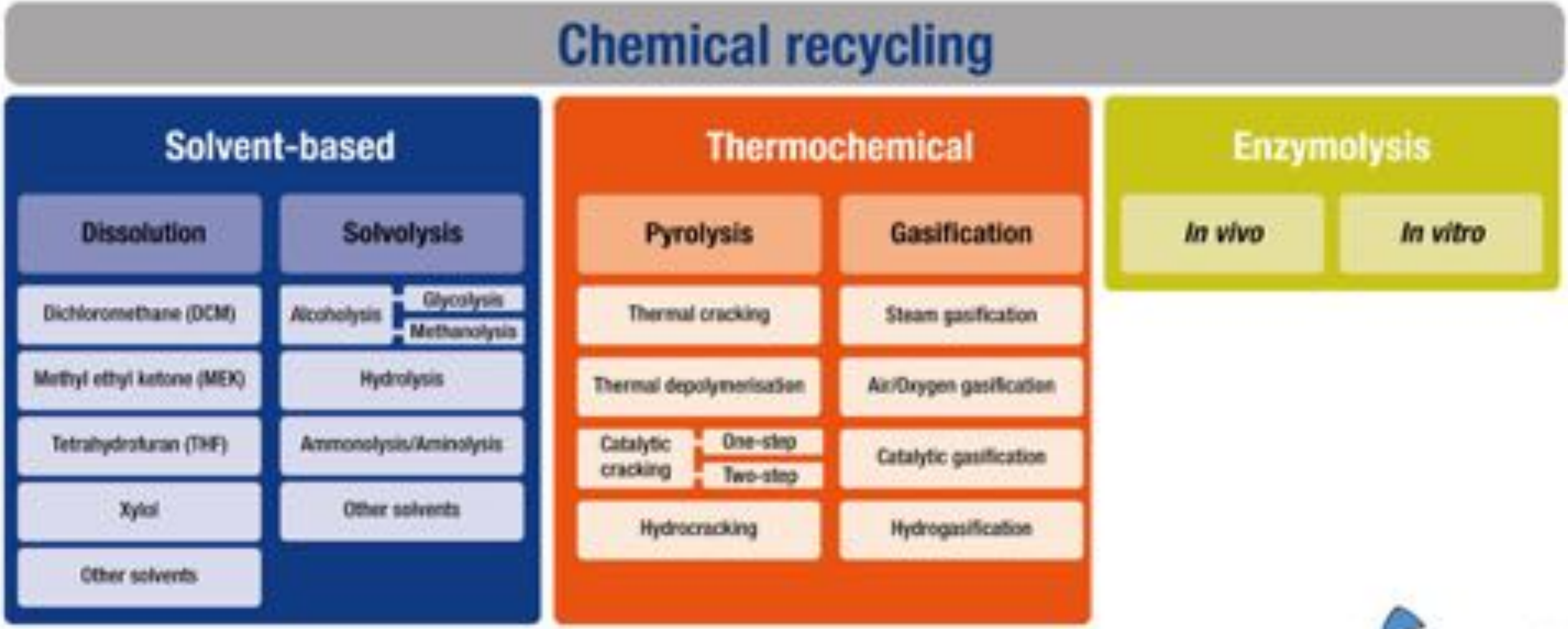
Pros in a nutshell

- Most important end-of-life option for plastics in the future circular economy
- Strong recycling targets in the European Union will guarantee access to renewable carbon from recycling
- Chemical recycling (different technologies): Basically no loss of quality compared to virgin feedstock

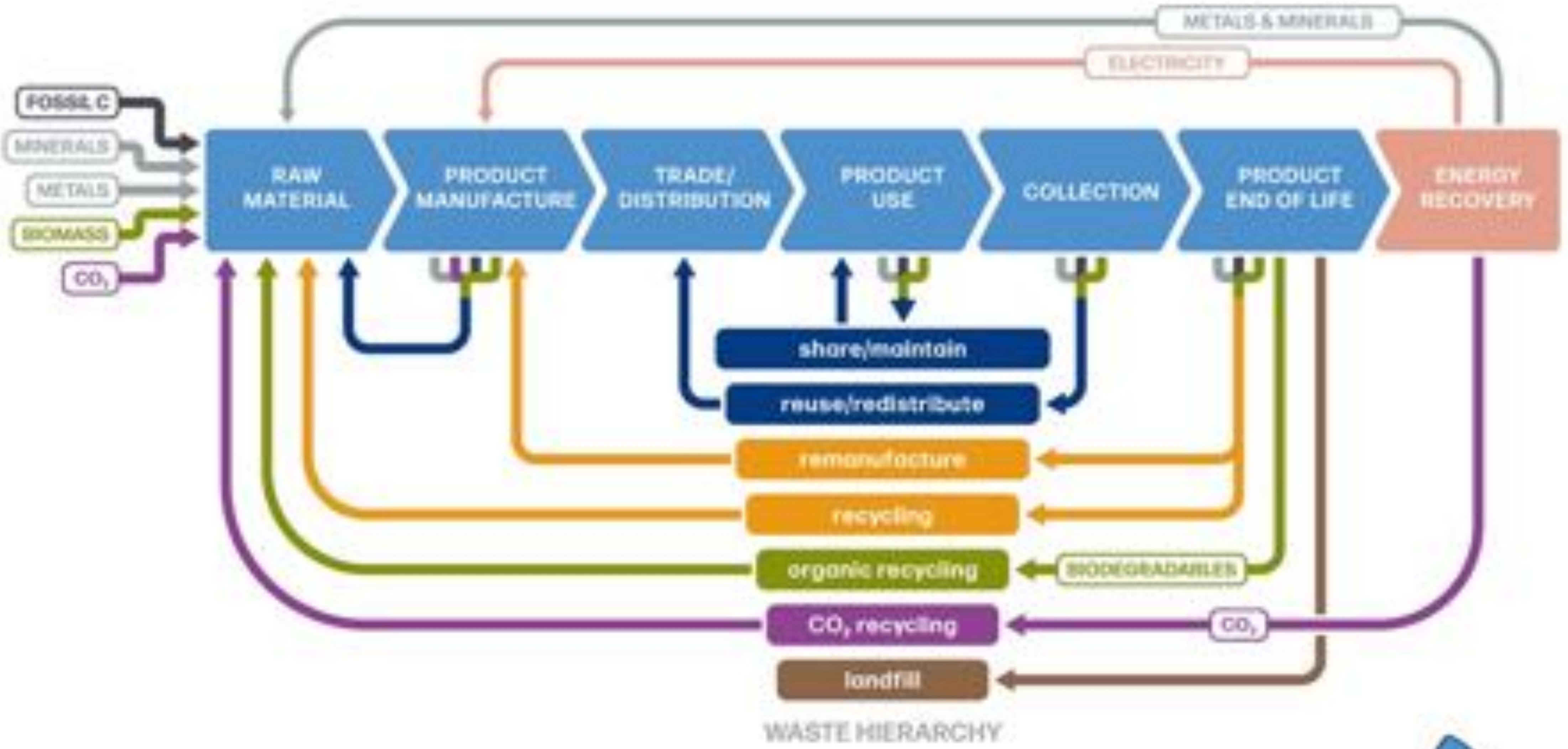
Cons in a nutshell

- Mechanical recycling: Limitation in quality, not allowed in many food applications
- Energy intensive processes
- Chemical recycling: early stage, first assessments on economic and environmental impacts available; investments waiting for clear political framework

Overview about the different methods for chemical recycling of plastic waste



Comprehensive Concept of Circular Economy



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Political Measures to Support a Quick Transition to Renewable Carbon (see nova paper #12)

- **CO_2 emission tax (heavily discussed in public – e.g. carbon border adjustment EU)**
- **Taxation of fossil carbon** used in chemicals and plastics
  - A raw materials tax is much easier to handle than an emissions tax.
  - We are not allowed to use any more additional fossil carbon – and that is exactly what makes the tax effective and important.
  - The tax only has to be charged in a few points (extraction and import).
  - Automatically captures all sectors and applications that use fossil carbon – without exceptions
  - Recycling, biomass and CO_2 are automatically exempt from the tax.
- **Discontinuation of any funding** programmes in the **fossil** domain (estimate 20 billion US$ in the US alone
- **Higher costs for fossil CO_2 emissions** in the emissions trading system (ETS).
- Development of **certificates and labels** which indicate the **share of renewable carbon.**
- Establishing **quotas of renewable carbon** for “drop in” chemicals and plastics and a **quota for CO_2-based kerosene**.
- **Report about the percentage of renewable carbon** used in the production processes of the chemical and plastic industry (**Ranking**)

Thank you for your attention!

Visit us at:
https://renewable-carbon-initiative.com/

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