



Renewable Carbon Refineries integrating Biomass, CO2 and Hydrogen as well as Chemical Recycling

- Challenges for Refineries and Verbund Sites
- Carbon flows, demand for embedded carbon
- "Renewable Carbon Refineries"

Achim Raschka, Head of Technology & Markets nova-Institute (Germany)



Your partner in strategy, technology and sustainability

# SCIENCE-BASED CONSULTANCY ON RENEWABLE CARBON FOR CHEMICALS AND MATERIALS

We support your smart transition to renewable carbon nova-Institute was founded in 1994 and has a multidisciplinary and international team of more than 40 scientists

Get to know our experts at: nova-institute.eu/nova-team RENEWABLE CARBON CO<sub>2</sub> Bio-based CO<sub>2</sub>-based Recycling

# **Circular Economy**



# nova-Institut GmbH – SME

private and independent research institute; multidisciplinary and international team of more than 40 scientists

### **Technology & Markets**

- Market Research
- Innovation & Technology Scouting
- Trend & Competitive Analysis
- Supply & Demand Analysis
- Feasibility & Potential Studies
- Customised Expert Workshops

#### Sustainability

- Tailor-made Life Cycle Assessments
- Customised Carbon Footprint Calculation Tools
- Social Impact Assessment & Social Acceptance
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- Critical Reviews

RENEWABLE CARBON

### Communication

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- Communication & Marketing Support
- Network of 60,000 Contacts to Companies, Associations & Institutes
- Targeted Newsletters for 17 Specialty Areas of the Industry
- Conferences, Workshops & nova Sessions
- In-depth B2C Research

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- Micro- and Macroeconomics
- Techno-Economic Evaluation (TEE) for Low & High TRL
- Target Price Analysis for Feedstock & Products
- Strategic Consulting for Industry, Policy & NGO's
- Political Framework, Measures & Instruments
- Standards, Certification & Labelling





# nova-Institute's Sustainability Department





renewable-carbon.eu

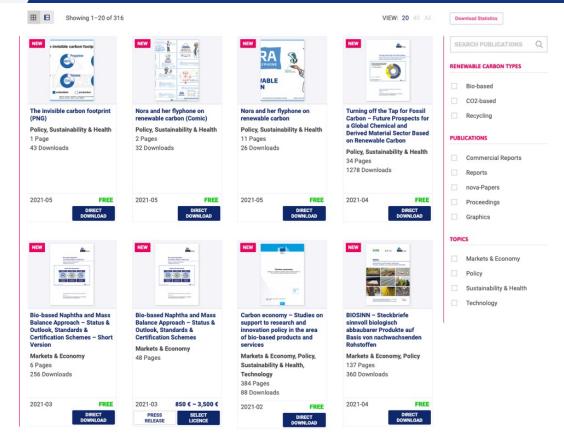


# nova provides studies on all renewable carbon relevant topics such as bio-based & CO<sub>2</sub>-based polymers as well as chemical recycling

# **Renewable Carbon Publications**

Over 300 publications on bio-based,  $CO_2$ -based and recycling by nova-institute

### www.renewable-carbon.eu/publications







The Best Available on Bio- an CO<sub>2</sub>based Polymers & Building Blocks and **Chemical Recycling** 

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# Renewable Carbon



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All news	<b>Bio-based</b>	CO2-based	Recycling	nova news
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#### 28306 news

3 September 2021

ITA Group becomes ITA Group International Centre for Sustainable Textiles Goal is the holistic biotransformation of textile technology and thus the use of biological principles for cycle-oriented value creation processes

#### ITA Group wird zur ITA Group International Centre for Sustainable Textiles

Ganzheitliche Biotransformation der Textiltechnik und damit die Nutzung biologischer Prinzipien für kreislauforientierte Wertschöpfungsprozesse

Fake plants – made from bio-based plastic VISTAFOLIA® - Artificial Green Walls Bringing Your Walls To Life

#### Luft, Wasser, Öl: Was PLA-Biokunststoff gut filtern kann – und was nicht Forschende der Zuse-Gemeinschaft haben ihre Resultate des kürzlich abgeschlossenen Forschungsprojekts "BioFilter" veröffentlicht

#### Using plastic waste to help solve sand shortages Does the world have a shortage of sand? At first, that might sound like a peculiar question

Does the world have a shortage of sand? At first, that might sound like a peculiar question

#### Economic Impact of US Biobased Products Industry

Established in 2011 underneath USDA's BioPreferred Program, the Certified Biobased Product Label is intended to spur economic development, create new jobs and provide new markets for farm commodities

#### Velocys: SAF collaboration with Toyo advances to commercial stage

Velocys announced on Aug. 31 that its collaboration partner, Toyo Engineering Corp., is starting the advanced engineering and design phase of a commercial scale biorefinery in Japan to produce sustainable aviation fuel (SAF)

#### MEPs blast Commission's flagship forest strategy as vague, overstepping EU remit

European lawmakers from across the political spectrum have united in criticism against the European Commission's new flagship Forest Strategy, describing it as vague and superficial while flagging concerns that it goes beyond the remit of EU competences

# RENEWABLE CARBON NEWS

Daily news on Bio-based and CO<sub>2</sub>-based Economy and Chemical Recycling Worldwide



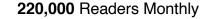
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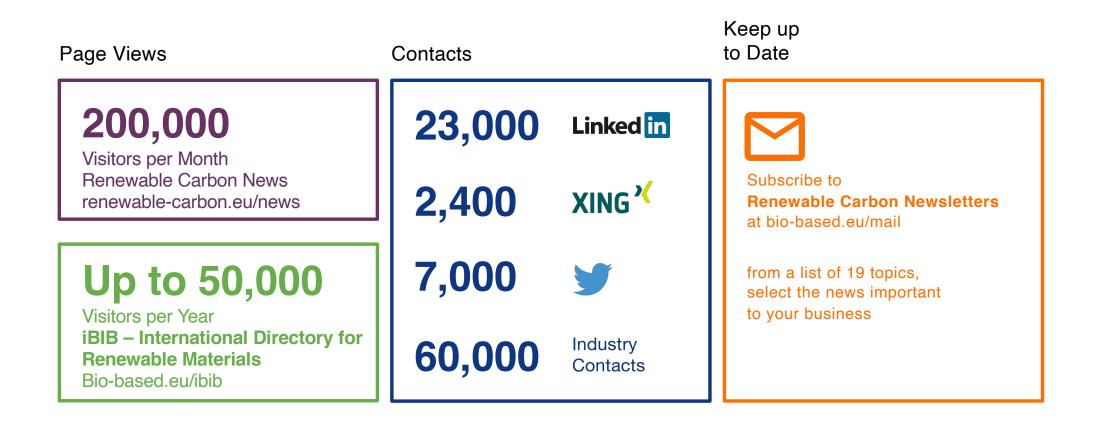


bioplastics

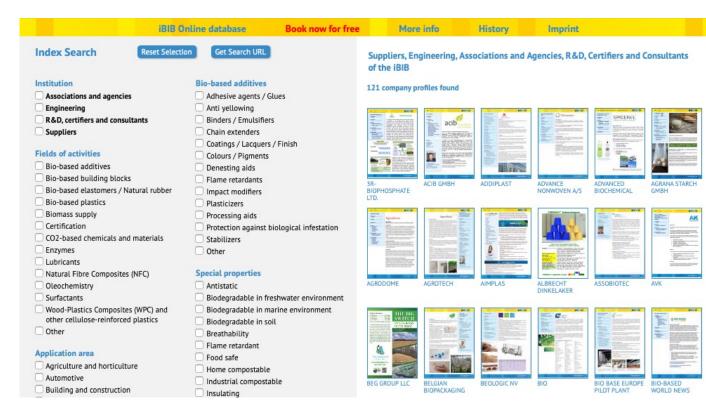
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### Networks



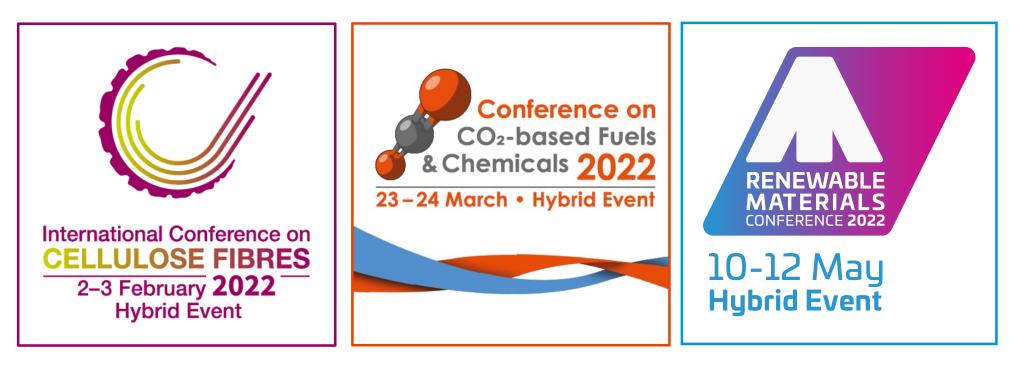
## **Renewable Carbon Companies (ReCaCo)**





- Up to 50,000 Downloads of Company Profiles per Year
- 121 Companies in the Database

# Save the Date



Contact: Mr. Dominik Vogt, +49 (0) 2233 48 14 49, dominik.vogt@nova-institut.de All conferences at renewable-carbon.eu/events



nova Institute Future of Refineries and Chemical Verbund Sites

- Challenges for Refineries and Verbund Sites
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RENEWA



# **OVA** Institute Chemical and Plastic Industry



- Of the total fossil carbon today, about 85% goes to energy and 10-15% to chemicals incl. plastics. The chemical sector will need more and more carbon in the coming decades, if only because of the growing world population and increasing prosperity. With decreasing demand from the energy sector, experts estimate that chemistry will account for about 50% of carbon demand in 2050.
- In order to hedge against shrinking demand from the energy and transport sectors, the big oil and gas companies are focusing entirely on the growing carbon demand from the chemical and plastics industries, which will also be met by fossil fuels in the long term.
- From a climate policy perspective, this strategy and the large quantities of fossil carbon associated with it, which will continue to enter the atmosphere as CO<sub>2</sub> for decades, can no longer be ignored.
- New political approaches are needed. Especially because you cannot decarbonise chemistry. Its products are made of carbon. And the new strategy is replacing the increasing demand for fossil carbon of the chemical industry by renewable carbon!





**Challenges for a Future Chemical Structure** 



# "Big Oil fears for its existence

For a long time they were considered invulnerable, now the oil multinationals have to fear for their future. After the climate ruling against Shell, "Big Oil" and other companies that emit a lot of CO<sub>2</sub> are under pressure.

## Shell must cut CO<sub>2</sub> emissions more drastically by 2030

For the first time, the Dutch court has obliged a company to comply with the requirements of the Paris climate protection agreement. It condemns the oil giant Shell to stricter climate targets. By 2030, the company would have to reduce its emissions by 45 percent compared to the level. Previously, Shell had planned a reduction of 20 per cent. The decision is a drumbeat. Source: https://www.tagesschau.de/wirtschaft/bigoil-bangt-um-seine-existenz-101.html

Brand owners are putting pressure on their supply chains to eliminate fossil carbon from their products by 2030.

What options do refineries and verbund sites have? Efficiency improvements are largely exhausted, the only way forward is renewable carbon.





**Challenges: New demand and production structure** 



- · Several refineries under revision
- Gaps in supply for chemical production

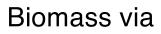
# Strong increasing share for E-mobility, hydrogen/methanol and fuel cells

- Decreasing demand for gasoline and diesel in the next decades (2050 only 10% from today)
- New balance for supply and demand needed, much higher share for chemicals
- Extensive investments will be necessary





# **Challenges: Integration of new feedstocks**



- HVO Diesel -> naphtha
- Ethanol -> ethylene
- Pyrolysis oil

# CO<sub>2</sub> plus H<sub>2</sub> (electrolysers) via

- methane / methanol
- Fischer-Tropsch (naphta and more)

# Chemical recycling

- Monomers from solvolysis
- Oil from pyrolysis
- Syngas from gasification
- Consolidation of waste recycling and disposal structures under the leadership of financially strong corporations





# **Challenges for a Future Chemical Structure**



So far, politicians are less aware of the necessary transformation of the chemical industry and there are no corresponding programmes and measures to support it. In the worst case scenario, the backbone of European industry could break away.

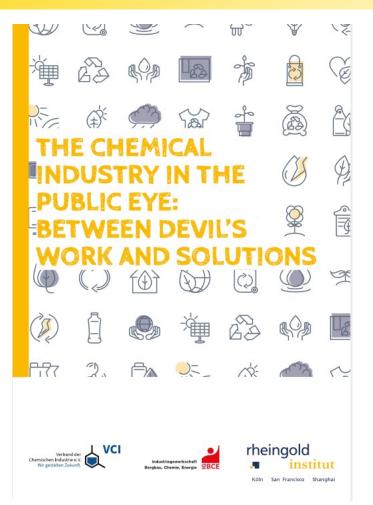
We have to raise awareness of the need for, and the technical, industrial and political feasibility of, the biggest transformation of the chemical and derived material sector since the industrial revolution.





# **Future Image of the Chemical Industry**





### **CHAPTER 5**

COMMITMENT THROUGH A COME-ALONG MENTALITY – CONCLUSIONS AND RECOMMENDATIONS FOR THE STRATEGIC POSITIONING OF THE CHEMICAL-PHARMACEUTICAL INDUSTRY

"Furthermore, **concrete commitment** means that clear and consistent decisions should be made that indisputably reduce or even avoid negative consequences of industrial production. Agreement on a **concrete roadmap for switching from fossil to alternative or renewable raw materials could also highlight such a commitment**."





nova Institute Future of Refineries and Chemical Verbund Sites



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# European Bioeconomy in Figures 2008–2017

Authors Olaf Porc, Nicolas Hark, Michael Carus, Lara Dammer (nova-Institut), Dr. Dirk Carrez (BIC)



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September 2020

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# Bioeconomy overall € 2.4 trillion

#### **Bio-based industries** Agriculture and forestry **Bio-based industries** Agriculture and forestry € 0.46 trillion 10.1 million € 0.75 trillion 3.6 million **Chemicals and Chemicals and** plastic materials plastic materials € 0.06 trillion 0.18 million **Employees** Turnover in the EU-28 in the EU-28 2017 2017 Food and feed Food and feed 4.8 million € 1.2 trillion

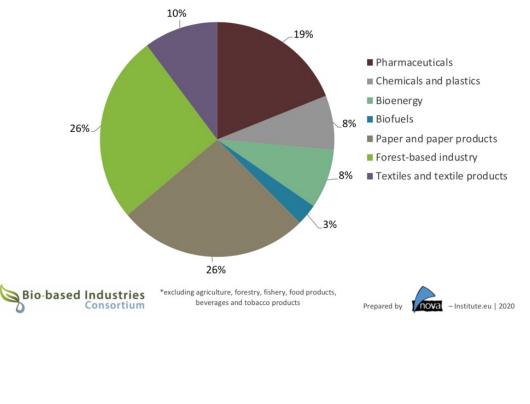
**Bioeconomy overall** 

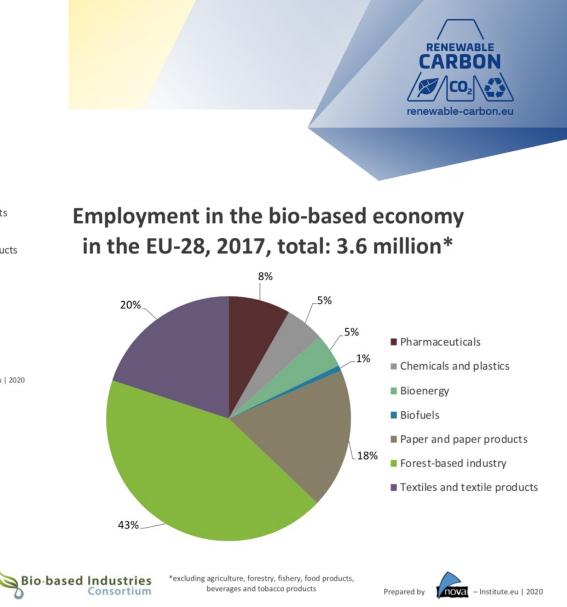
18.5 million





# Turnover in the bio-based economy in the EU-28, 2017, total: 750 billion Euro\*







# Summer survey 2020 by nova and COWI



First survey on the existing of renewable carbon in the chemical industry and sent a questionnaire to the 50 largest chemical companies producing in Europe. About 20% of the companies returned the completed questionnaire. "What is the share of the different carbon sources in the total carbon use in your European production?"

The results of the survey clustered chemical companies by their branch and share of renewable carbon into the following four groups:

- Traditional petrochemical companies show renewable carbon shares of 1-5%
- Several wood-based chemical companies show renewable shares of 80-90%
- In between is a group of mainly chemical companies with a traditional focus on plant oils and animal fats showing 40-50% renewable carbon shares
- Notably, a small number of petrochemical companies, which had renewable carbon shares of <1% in the past, already developed to shares around 20%

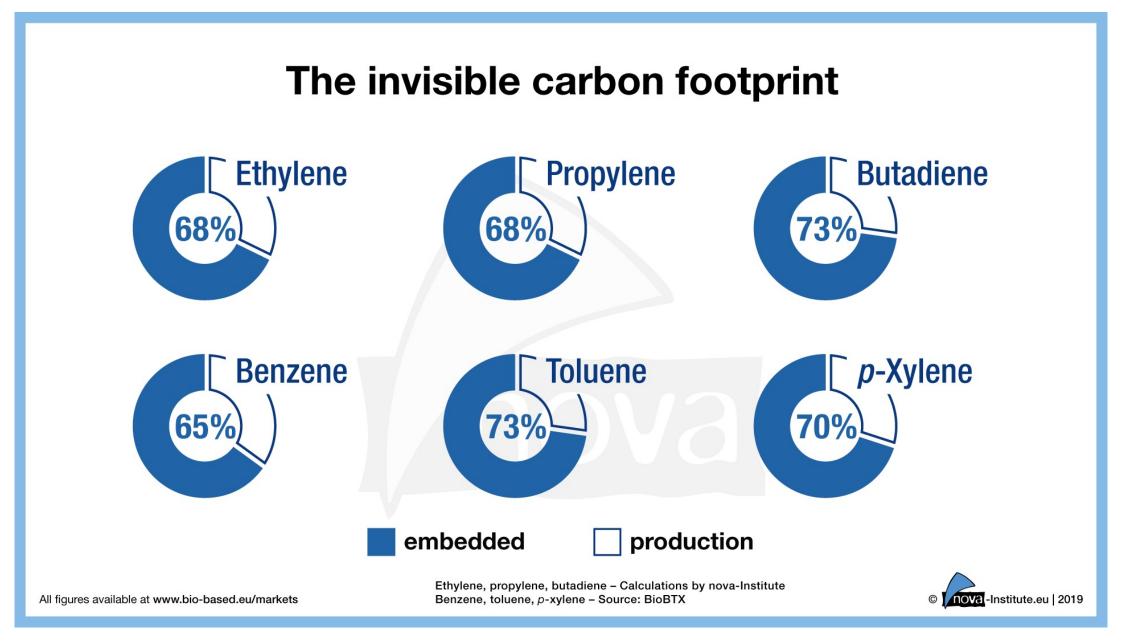
Currently, the largest share of renewable carbon is provided via **biomass** from agriculture and forestry, but **recycling** shares are increasing and the **utilisation of CO**<sub>2</sub> begins in a serious way. Most of the chemical companies have already or are currently developing concepts and strategies to increase the share of renewable carbon.

nova-Institute and COWI estimate that the current average renewable carbon share in the European chemical and plastic industry lies between 20 and 25% – 15% from biomass and 5-10% from recycling.

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PUBLICATIONS CONTACT

RENEWABLE CARBON PUBLICATIONS > MARKETS & ECONOMY > CARBON ECONOMY - STUDIES ON SUPPORT TO RESEARCH AND INNOVATION POLICY IN THE AREA OF BIO-BASED PRODUCTS AND SERVICES

FREE



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

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

AUTHORS	COWI, Directorate-General for Research and Innovation (European Commission), nova-Institute, Utrecht University
DATE OF PUBLICATION	Feb 2021
PAGES	384
LANGUAGE	
FILE TYPE	PDF
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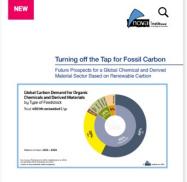


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#### RENEWABLE CARBON PUBLICATIONS > POLICY >

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



Christopher vom Berg April 2021

This and other reports on renewable carbon are available a

#### Chemical and Derived Material Sector Based on Renewable Carbon FREE

Turning off the Tap for Fossil Carbon - Future Prospects for a Global

### 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		
DATE OF PUBLICATION	Apr 2021		
PAGES	34		
LANGUAGE			
FILE TYPE	PDF	This study has been carried out or	
DOWNLOADS	96		
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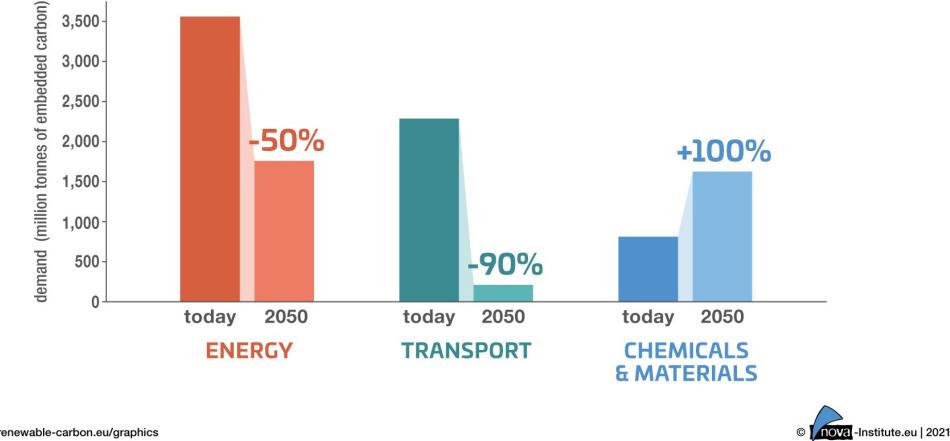
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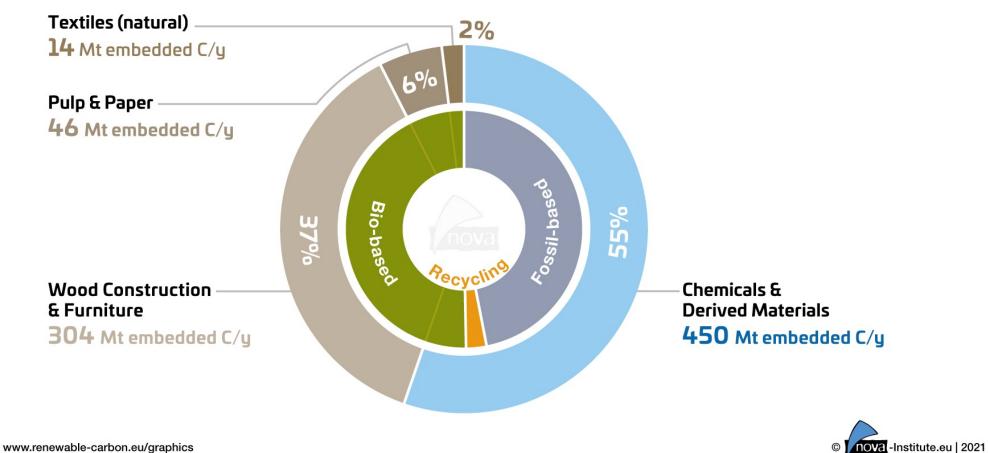
# **Embedded Carbon Demand for Main Sector**

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



available at www.renewable-carbon.eu/graphics

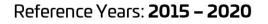
# **Global Carbon Demand for Chemicals and Materials by Sectors** Total: 814 Mt embedded C/yr – Reference Years: 2015 – 2020



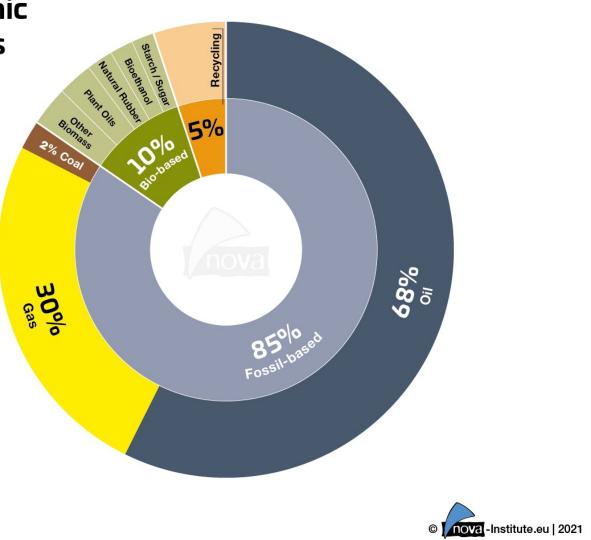
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**Global Carbon Demand for Organic Chemicals and Derived Materials** by Type of Feedstock

Total: 450 Mt embedded C/yr

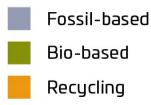


Main Sources: Piotrowski et al. (2015), Hundertmark et al. (2018), Levi and Cullen (2018), Skoczinski et al. (2021) available at www.renewable-carbon.eu/graphics



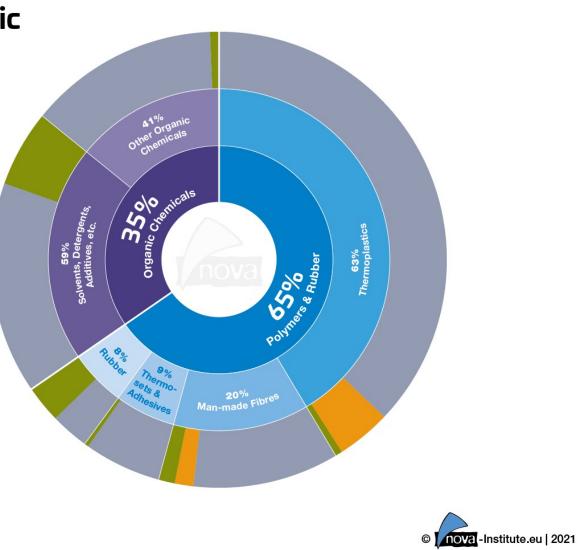
**Global Carbon Demand for Organic Chemicals and Derived Materials** by Product Group

# Total: 450 Mt embedded C/yr



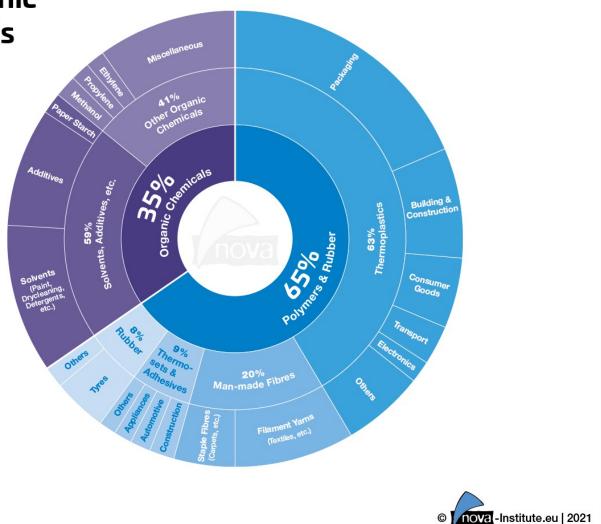
#### Reference Years: 2015 – 2020

Main Sources: Piotrowski et al. (2015), Hundertmark 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 End-user Application

Total: 450 Mt embedded C/yr

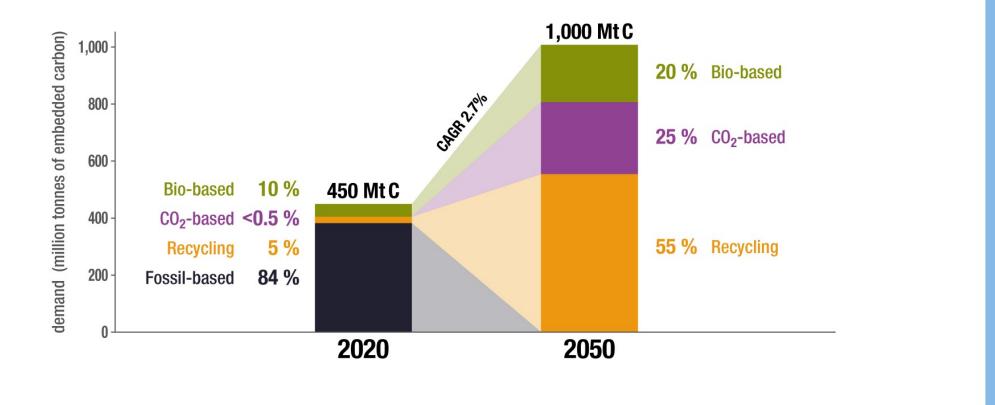


Reference Years: 2015 – 2020

Main Sources: Geyer et al. (2017), Levi and Cullen (2018), Mordor Intelligence (2019), The Fiber Year Consulting (2020), Skoczinski et al. (2021) available at www.renewable-carbon.eu/graphics

# **Global Carbon Demand for Chemicals and Derived Materials**

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





available at www.renewable-carbon.eu/graphics

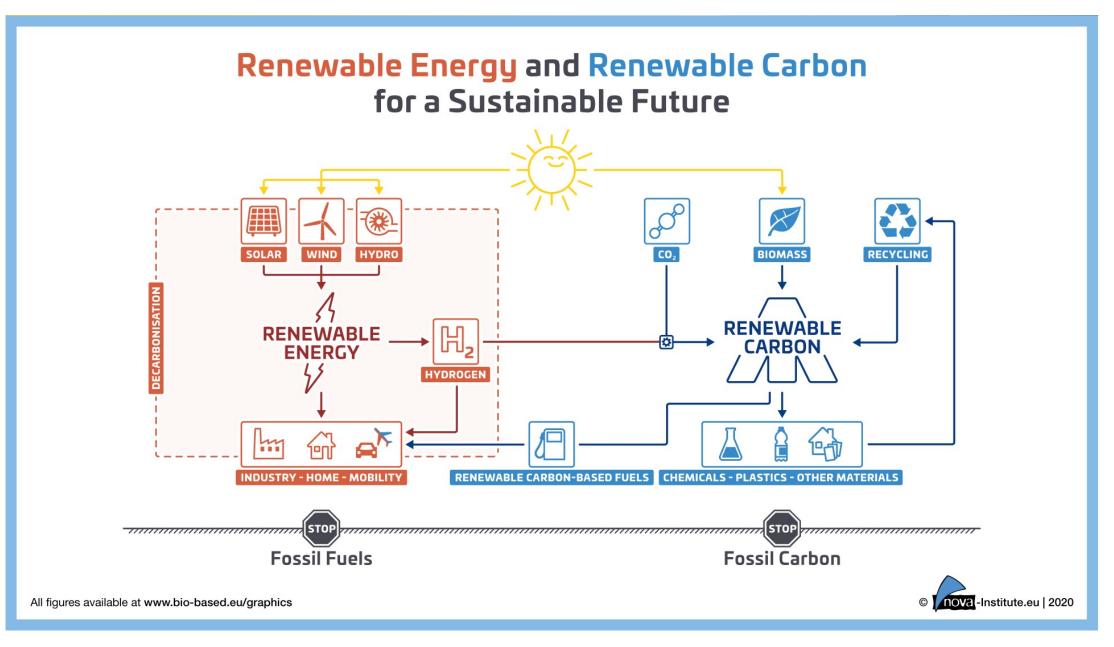


**Future of Refineries and Chemical Verbund Sites** 

- Challenges for Refineries and Verbund Sites
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# 



# **RENEWABLE CARBON**

entails all carbon sources that avoid or substitute the use of any additional fossil carbon from the geosphere.

Renewable carbon can come from the atmosphere, biosphere or technosphere – but not from the geosphere. Renewable carbon circulates between biosphere, atmosphere or technosphere, creating a carbon circular economy.

Fossil carbon shall be completely substituted by renewable carbon, which is carbon from alternative sources: biomass, CO<sub>2</sub> and recycling. This is the only way for chemicals and plastics to become sustainable, climate-friendly and part of the circular economy – part of the future!

#renewablecarbon

# www.renewable-carbon-initiative.com



Key points of the renewable carbon concept



- 72% from the GHG emissions are directly related to additional fossil carbon from the ground.
- Climate change is likely to become one of the most significant drivers of biodiversity loss.
- **Decarbonisation** with renewable energies is a **good strategy for the energy sector**, but no issue for chemicals and materials, because most of them are based on carbon (just like humans ☺).
- There is a lasting need for carbon for chemicals and materials. All fossil carbon use has to end, as the carbon contained in the molecules of chemicals and plastics is prone to end up in the atmosphere sooner or later. Only a full phase-out of fossil carbon will help to prevent a further increase in CO<sub>2</sub> concentrations.
- The key challenge is to **replace demand** for fossil carbon by alternative carbon sources.
- The equivalent to decarbonisation in the energy sector is a transition to renewable carbon in the chemical and material industries.
- Those alternative carbon sources are biomass, CO<sub>2</sub> and recycling of carbon containing waste streams (bio and plastic waste) – we need them all together to replace fossil carbon.
- We call them "renewable carbon".





# **Renewable Carbon is the Key**





For the first time since the industrial revolution, technology allows us to decouple the chemical, plastics, fibre and other material industries from the use of fossil carbon.

Demand for Carbon Management

Background nova-paper #12: "Renewable Carbon – Key to a Sustainable and Future-Oriented Chemical and Plastic Industry"

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# MEMBERS OF THE INITIATIVE

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www.renewable-carbon-initiative.com



# **Ongoing and planned activities of the RCI**



- Advocating the renewable carbon concept to policy-makers at the EU level
- Develop argumentation in favour of renewable carbon as a guiding principle in future assessments
- Analyse the **GHG reduction potential of CCU** (and potentially other RC sources as well)
- Provide simple examples (a comic) and good examples (case studies) to increase accessibility
- Create a **RC community** for networking, project development and building supply chains
- Three Working Groups for members have started
  - RC certificate & label for the RC share in chemicals, materials and products
  - Communication, press releases, LinkedIn, Twitter
  - **Policy**, ongoing policy framework analysis: What is in the pipeline and when is the ideal time to influence it?
  - More will come ...

# Which activities would you like to see?





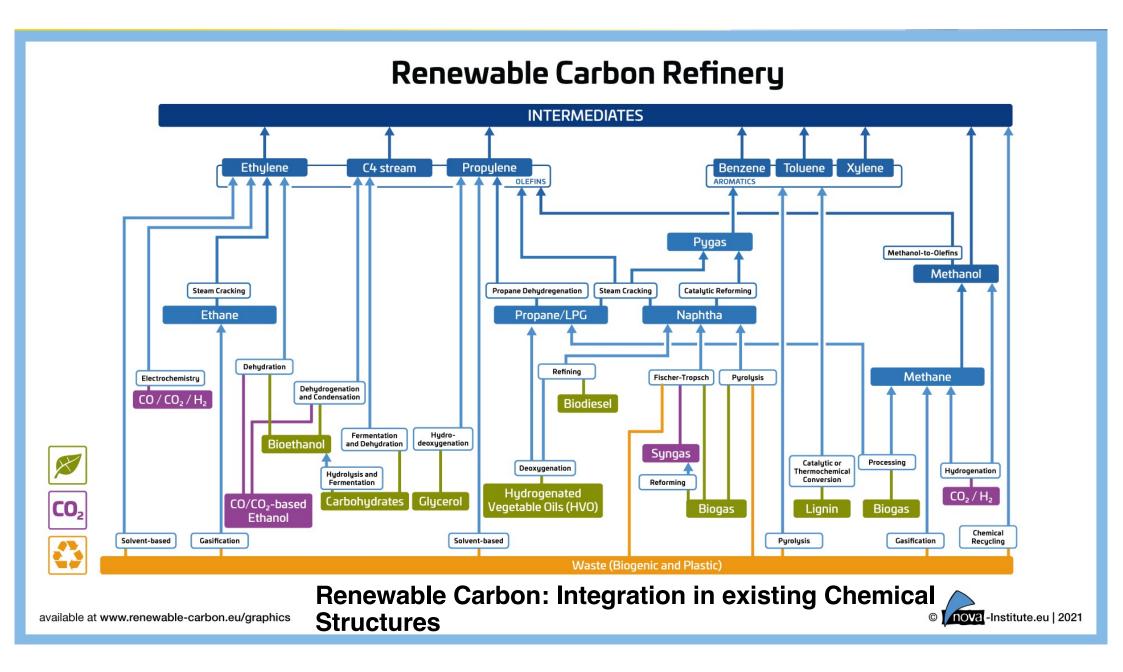
# **Carbon Management**



Which of the renewable carbon options comes into play in a specific case is the topic of future carbon management.

- Policy should provide a general market pull for renewable carbon, without regulating the individual renewable carbon streams which could also lead to undesirable side effects with a high risk.
- Which of the renewable carbon options comes into play should be decided by feedstock availability, technology and market conditions as well as specific environmental issues. This depends on regional factors and concrete applications and production pathways.
- There is no one-size-fits-all answer ... except that it has to be renewable carbon. Renewable carbon is globally necessary for the chemistry of the future, but locally insufficient here additional sustainable criteria play an important role.
- Example Biofuels: The demand for biofuels will decline drastically over the next decades in parallel with the success of the electric vehicle and the hydrogen fuel cell. It would be the task of politics to support the transformation of bioethanol and biodiesel producers into producers of raw materials for the chemical industry. In this way, the considerable investments and technological developments would not be lost and no additional arable land would be needed to supply the chemical industry with renewable carbon.







# nova-Institute







Linda Engel COO & Head of Communication

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Stefanie Clermont CFO





Christopher vom Berg Economy & Policy Deputy



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# Thank you for your attention!





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Renewable Carbon Industrial Biotechnology Carbon Capture & Utilisation

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