Renewable Carbon Strategy

on

Chemicals and Polymers

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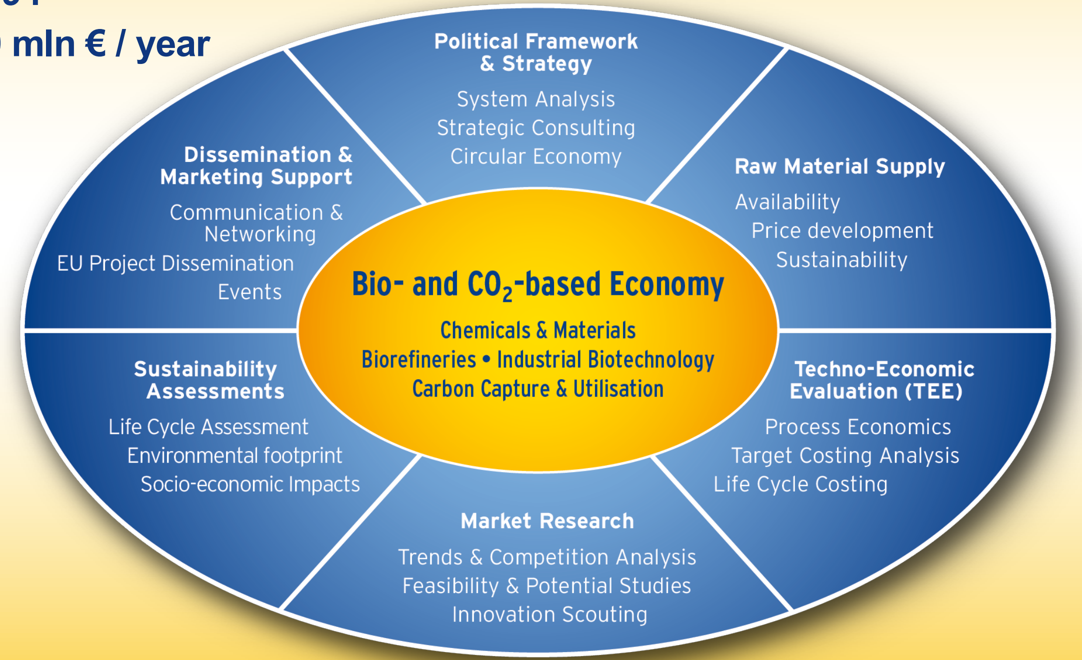

Selected Customers from all Industrial Sectors

BIG BioInnovation Growth mega-Cluster
BMW
BASF We create chemistry
LEIFHEIT AKTIENGESELLSCHAFT
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CO_2 VALUE EUROPE
PORSCHE
NESTE
Tetra Pak PROTECTS WHAT'S GOOD
KPMG
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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meo CONSULTING TEAM
NIA

Selected Customers from Chemical Industry

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cefic
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Honeywell
TEIJIN

Arizona CHEMICAL
Corbion purac
ExxonMobil Energy lives here
KRATON
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DSM
FKuR plastics - made by nature!®
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GOLDEN COMPOUND
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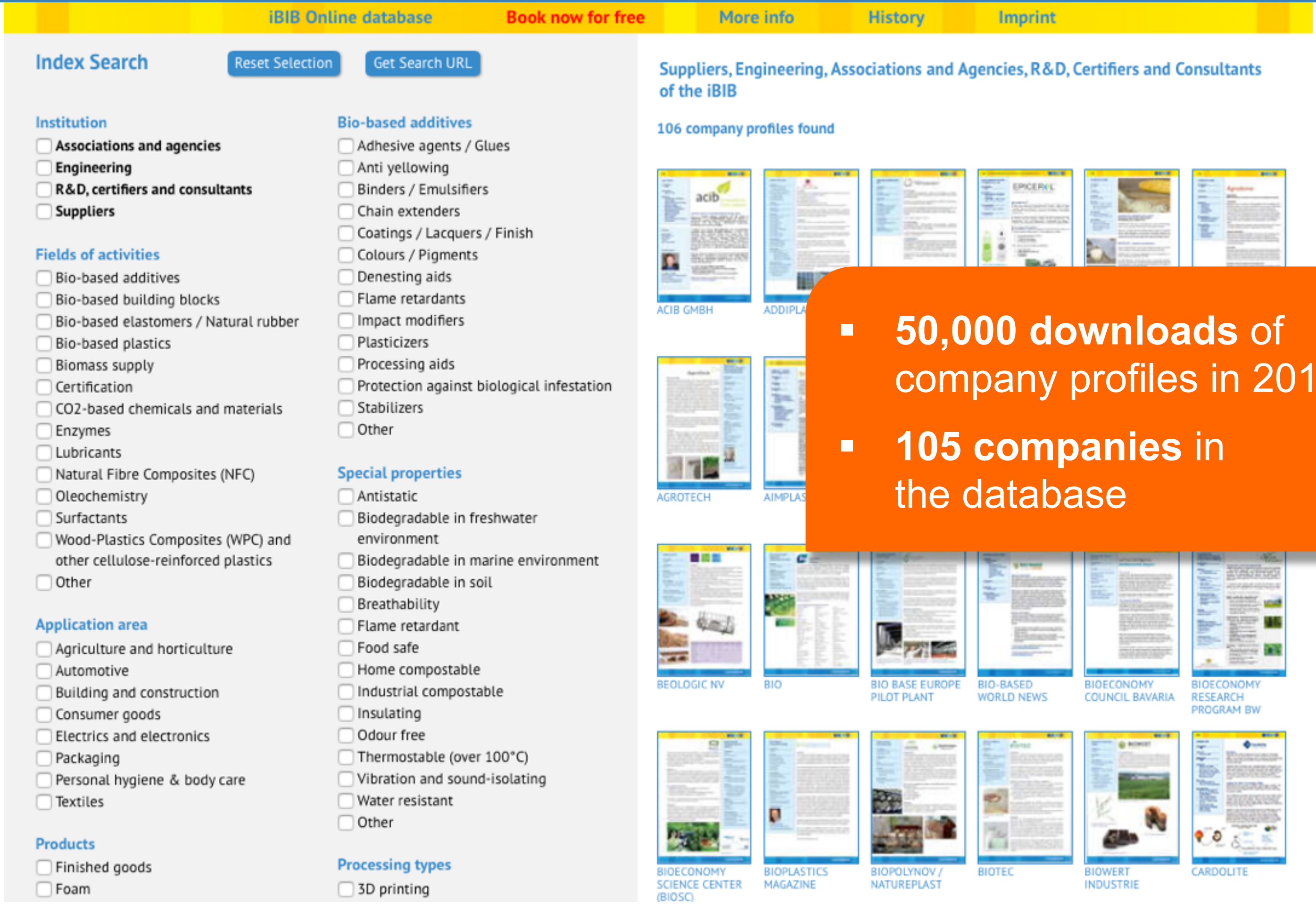

- **50,000 downloads** of company profiles in 2018
- **105 companies** in the database

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Strategy 2020

Renewable Carbon is the Key to a Sustainable and Future-Oriented Chemical and Plastic Industry

Major threats and challenges to our planet are

- Climate change and
- Biodiversity loss

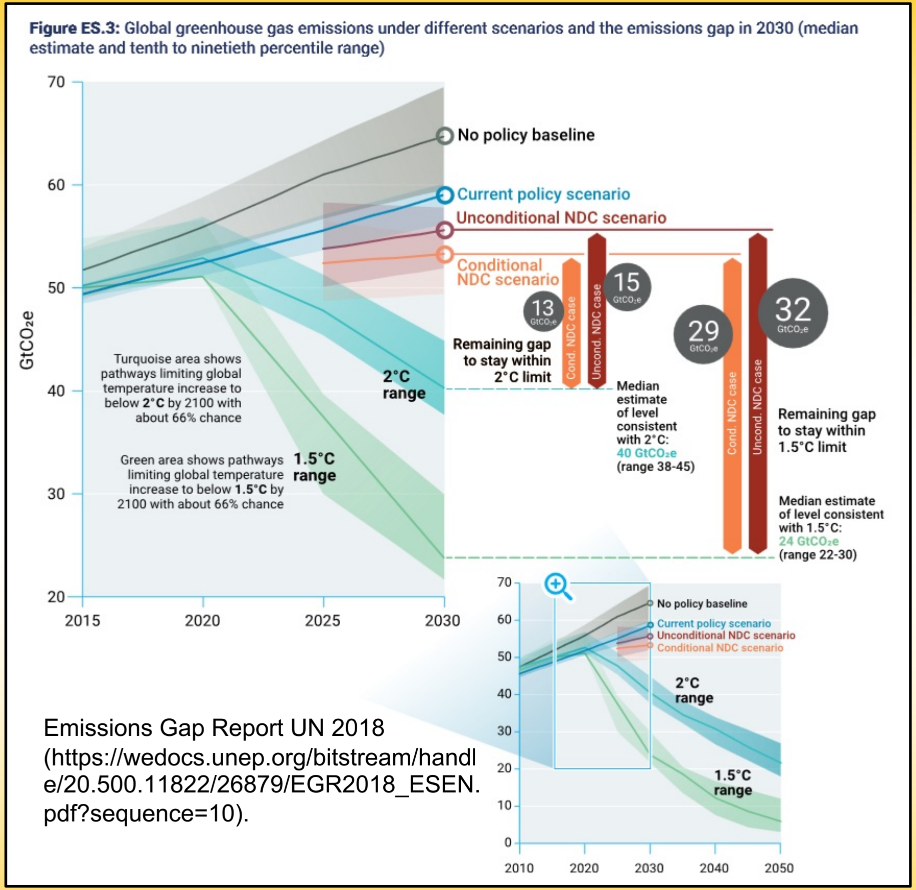
The main reason for climate change

- 75%: CO_2 emissions
- Mainly fossil CO_2 emissions from utilised crude oil, natural gas and coal

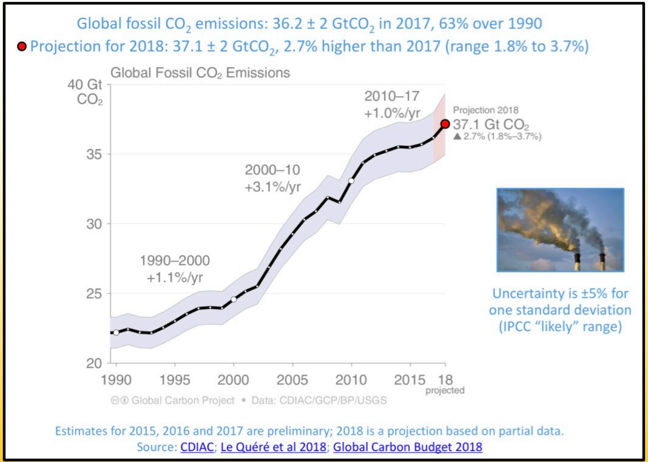
The main reasons for the biodiversity loss

- **Climate change**, alongside factors like land degradation and habitat loss, is emerging as a top threat to wildlife around the globe. https://www.scientificamerican.com/article/climate-change-is-becoming-a-top-threat-to-biodiversity/
- According to the Millennium Ecosystem Assessment, **climate change is likely to become one of the most significant drivers of biodiversity loss by the end of the century**. Climate change is already forcing biodiversity to adapt either through shifting habitat, changing life cycles, or the development of new physical traits. https://www.cbd.int/climate/intro.shtml
- By the end of the century, **climate change** and its impacts may be the **dominant direct driver of biodiversity loss** and changes in ecosystem services globally. https://www.greenfacts.org/en/biodiversity/l-3/4-causes-desertification.htm

- All time record: 37 Gt fossil CO_2 emissions in 2018 (below)
- More than 50 Gt CO_2e in 2018 (left), 2019: 55 Gt CO_2e
- In 2030 (1.5 Grad C range): about 24 Gt CO_2e are allowed (left)



Emissions Gap Report UN 2018 (https://wedocs.unep.org/bitstream/handle/20.500.11822/26879/EGR2018_ESEN.pdf?sequence=10).



STOP Fossil Carbon Use

Globally, a third of oil reserves, half of gas reserves and over 80 per cent of current coal reserves should remain unused from 2010 to 2050 in order to meet the target of 2°C.

McGlade & Ekins 2015: The geographical distribution of fossil fuels unused when limiting global warming to 2°C. Nature 2015; 517:187–190.

- Only a **full phase-out of fossil carbon** will help prevent a further increase in CO_2 concentrations.
- All of the **fossil carbon extracted from the ground** will sooner or later be **released into the atmosphere** where the CO_2 concentration will go up as a consequence.

“Renewable Energy”
Decarbonisation of the Energy Sector

There is a clear and more or less consistent Energy Policy to a 100% renewable energy system based on **solar, wind, hydro** and other renewable energies.

Apart from bioenergy, bio- and CO_2-based fuels, all of these deserve the term **“decarbonisation”**.

Green electricity and **green hydrogen** for the **energy** and **fuel sector**.

"Renewable Carbon" for a Sustainable Chemical and Plastic Industry

There is no corresponding policy or strategy for the material sector, especially for the chemical and plastic industry.

The term **decarbonisation** is **sheer nonsense** for organic chemistry, which is based on carbon. It is used out of lack of knowledge and as a direct analogue to the energy field. We should NEVER use it in this context!

But the term is not only nonsense, it is even risky because it avoids the **question of the "right" carbon sources.**

And this is exactly what we have to provide. We need a future oriented renewable carbon strategy. And there are only three sources of renewable carbon.

RENEWABLE CARBON

CO_2

Renewable Carbon is the Key

Definition

Renewable Carbon means all carbon sources that **avoid or substitute 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 atmosphere, biosphere and technosphere.

Similar concepts and strategies

“In the **carbon reuse economy** fossil carbon is left in the ground while aboveground carbon circulates without accumulating to the atmosphere. … we believe that the carbon reuse economy can have a significant role in mitigating climate change and creating new business based on sustainable carbon.” (VTT 2019)

Already in 2016, the Finnish consulting firm Pöyry used the term **“recarbonisation”** in a similar way, but with limitation to biogenic carbon. (Pöyry 2016)

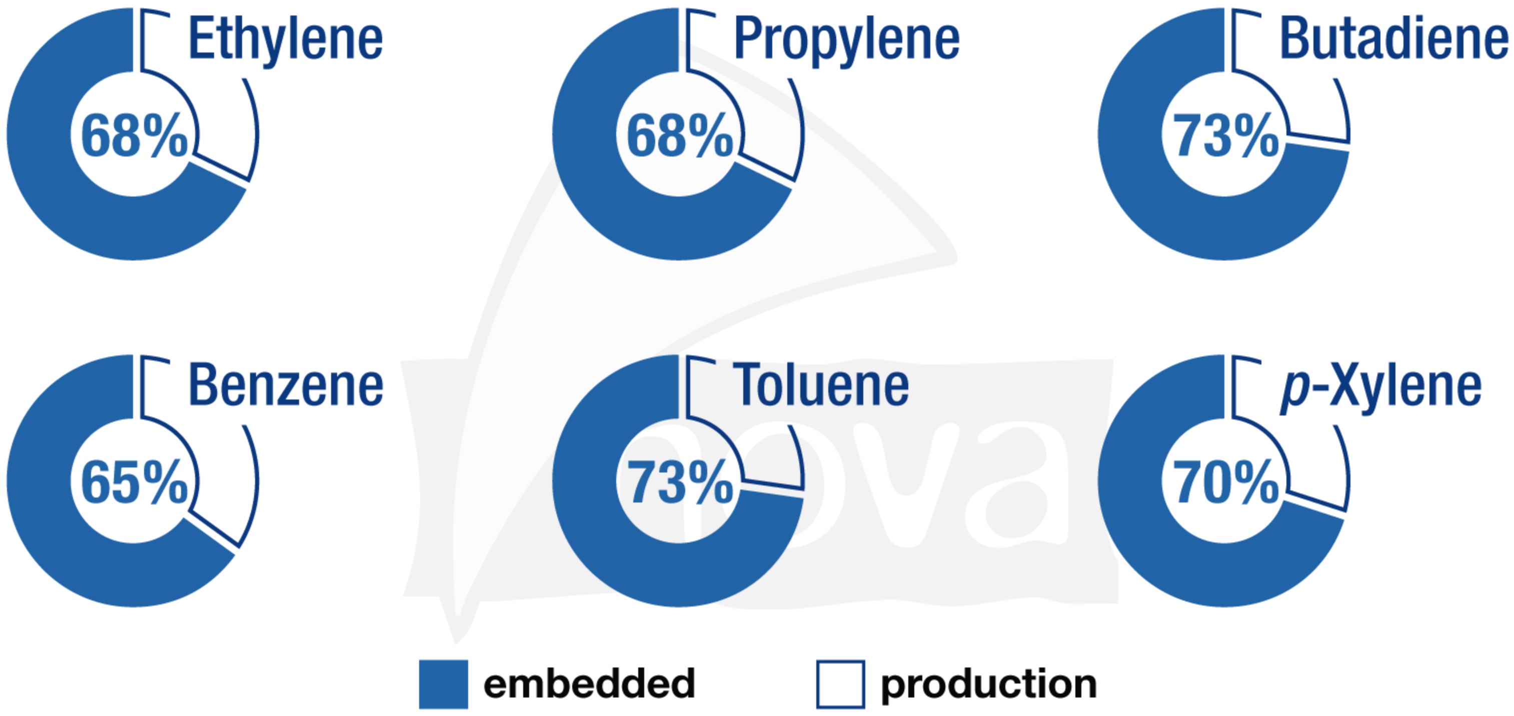
In the roadmap for the Dutch Chemical Industry towards 2050, the authors use the term **“Circular & Biobased”**, not including the carbon utilisation, which is mentioned as an additional area. (VNCI 2018)

The European Commission includes in their plastic strategy the **three non-fossil carbon sources** (EC 2019): „ Using more **recycled** plastics can reduce dependence on the extraction of fossil fuels … **Alternative feedstocks**, including bio-based feedstocks and gaseous effluents (e.g. carbon dioxide or methane) can also be developed to avoid using fossil resources.”

RENEWABLE CARBON

CO_2

The invisible carbon footprint



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

All figures available at **www.bio-based.eu/markets**

There are only three sources of renewable carbon

- Renewable carbon from **recycling** of already existing plastics and other organic chemistry products, from the *Technosphere*

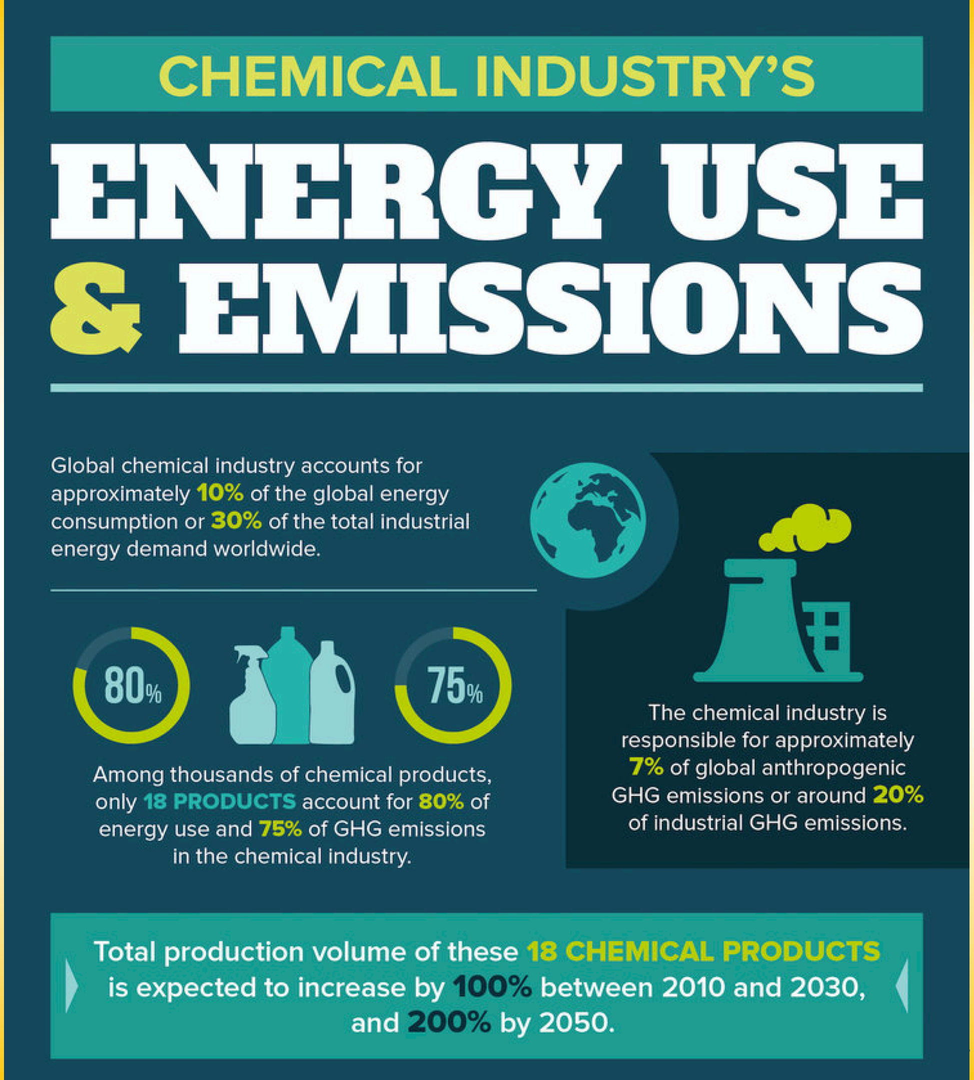
- Renewable carbon gained from all types of **biomass**, from the *Biosphere*

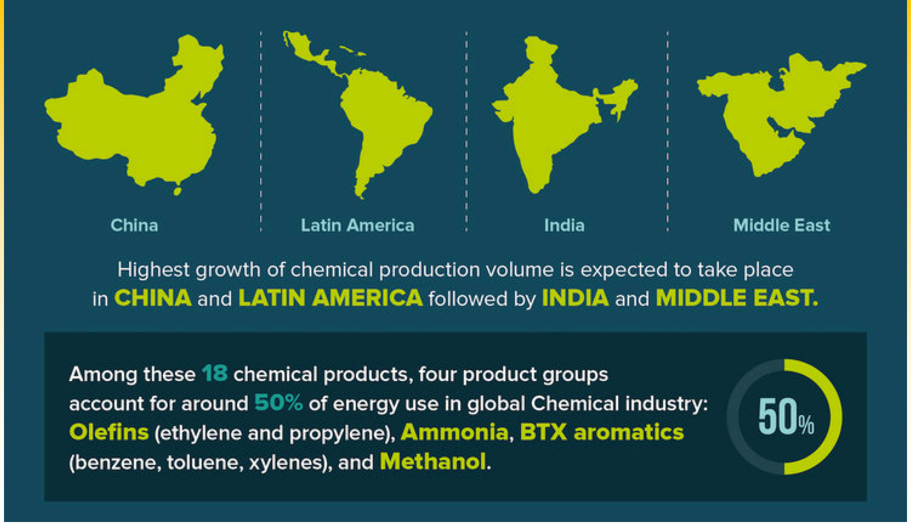
- Renewable carbon from **direct CO_2 utilisation**, from the *Technosphere* and *Atmosphere*

The equivalent to decarbonisation in the energy sector is a transition to renewable carbon in the chemical and plastics industries.

Strategy in detail

- All three carbon sources are essential for a complete transition to renewable carbon, and
- all of them should be similarly used by the industry and supported by politics.
- Don't fight a brother war! There'd only be one winner: Fossil carbon.
- Share to win!
- To replace all the additional fossil carbon, we need the smartest mix of all three.
- We need a future materials policy – a policy on renewable carbon.
- **Which of the renewable carbon options come into play should be decided by technology and market forces and not by politics**. This depends on regional factors and concrete applications.





www.globalefficienyintel.com

- 2018: Chemical Industry 7% of the global GHG emissions
- 2030: 15%?
- Why? Higher CAGR for chemistry compared to energy & decarbonisation of the energy sector

Renewable Carbon is the key

The chemical and plastic industry may only develop into a sustainable sector once it bids farewell to fossil raw materials such as crude oil, natural gas and coal for good and **uses nothing but renewable carbon as a raw material in organic chemistry**.

The equivalent to decarbonisation in the energy sector is a transition to renewable carbon in the chemical and plastics industries.

Crude oil $200/barrel for Cost Parity

The "**ROAD MAP CHEMIE 2050 - Towards a Greenhouse Gas Neutral Chemical Industry in Germany**" published by DECHEMA and FutureCamp in 2019 develops three possible scenarios for the German chemical industry, the scenario "greenhouse gas neutral path 2050" shows:

“The new, electricity-based processes will increase the electricity demand of the German chemical industry to 685 TWh per year from the mid-2030s, which is more than the total electricity production in Germany of 2018. ... Companies would have to invest around 68 billion euros more between 2020 and 2050, most of it from 2040 onwards. The conversion of the basic chemical processes examined in the roadmap alone entails additional investments of up to around 45 billion euros.”

Based on the data of this study, we have calculated which oil price would be necessary, so that the complete switch to CO_2 would be cost neutral. The result is $200 per barrel, more than three times compared with today crude oil price.

Non-energetic demand from the Chemical Industry

Our own calculation shows that for the production of 20 PWh solar power only 0.9% of the Sahara region is needed to cover the global non-energetic carbon demand of the chemical and plastics industry from 2018.

The PV yield in the Sahara is typically about 250 GWh/km^2/y (Breyer 2019).

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

Plastic production today (world)

We need them all!

	Fossil-Based Plastics	Bio-Based Plastics	Recycled Plastics	CO_2-based Plastics
Production in 2019	400 Million tonnes	4 Million tonnes	20 – 40 Million tonnes	< 500,000 tonnes
CAGR 2020-2025	3 – 4%	3%	> 6%	?

Bio-based Plastics in a Crisis?

- **No political recognition** of the **benefits, potential and necessity** of bio-based and biodegradable polymers. **Slow growth** due to higher costs.
- **More barriers than policy support**.
- In strong **contrast to biofuels** and bioenergy, which are strongly supported by quotas (REDI and II).
- NGOs say "The use of biomass puts an **unacceptable pressure on land and biodiversity**." A statement stronger than 50 scientific reports.
- **No food-crops for industry**. Even paper uses far more starch than bio-based plastics. Europe has an overproduction of beet sugar, the image of food is an obstacle to marketing.
- **Recycled plastics** are often the preferred option.
- **Green Deal**: Bioeconomy is almost not mentioned, seems to have become more of a problem to manage than an option for the future.
- **But at the same time: Demand from the market for more environmental friendly materials.**

A new strategy is needed that takes up the benefits and allies with other sustainable materials. Share to win.

Strategy 2020

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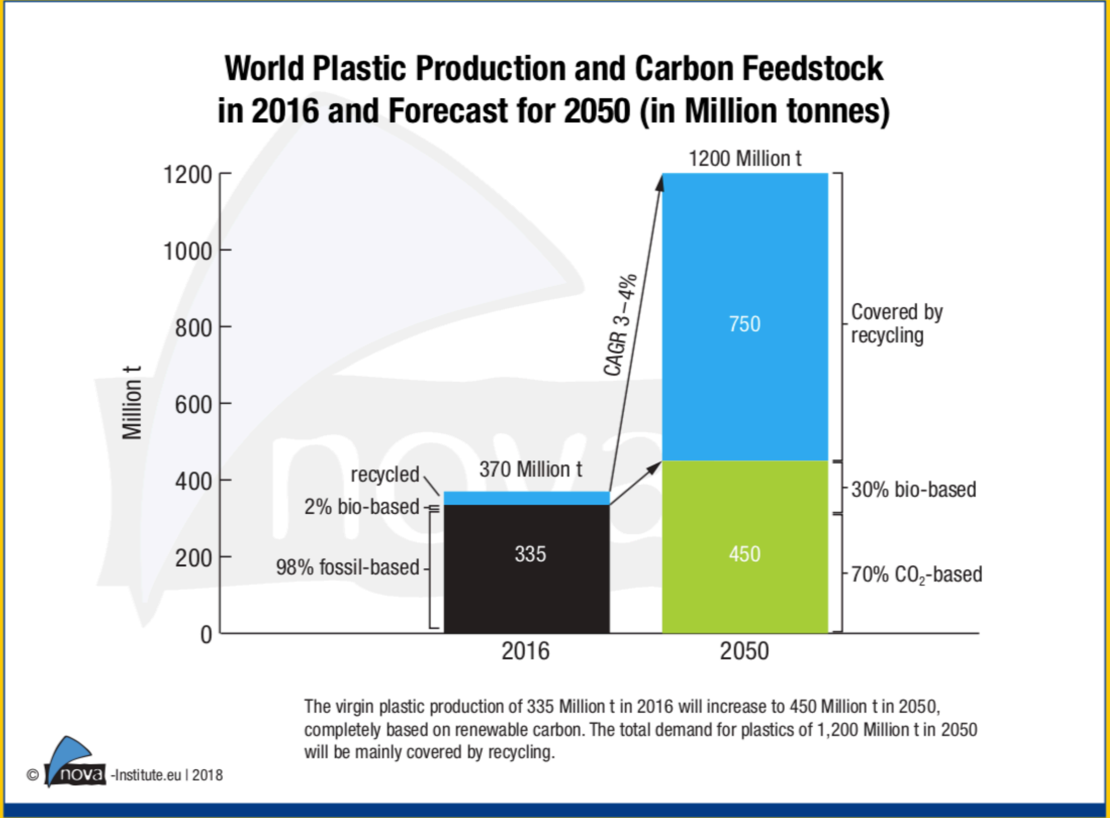
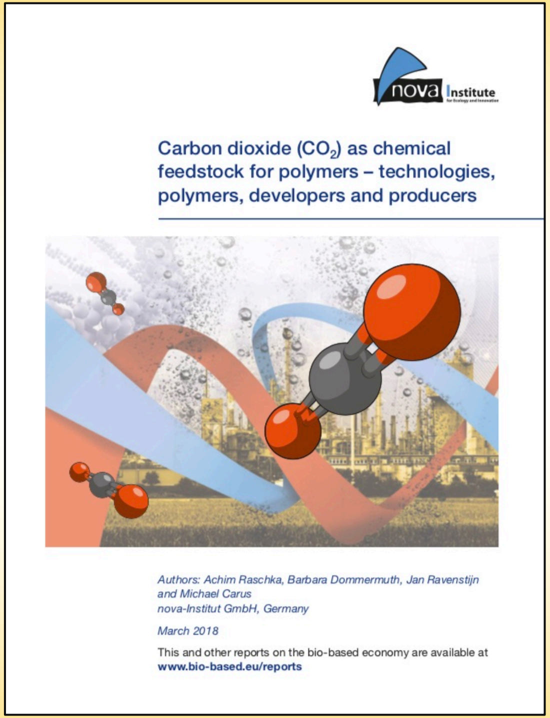
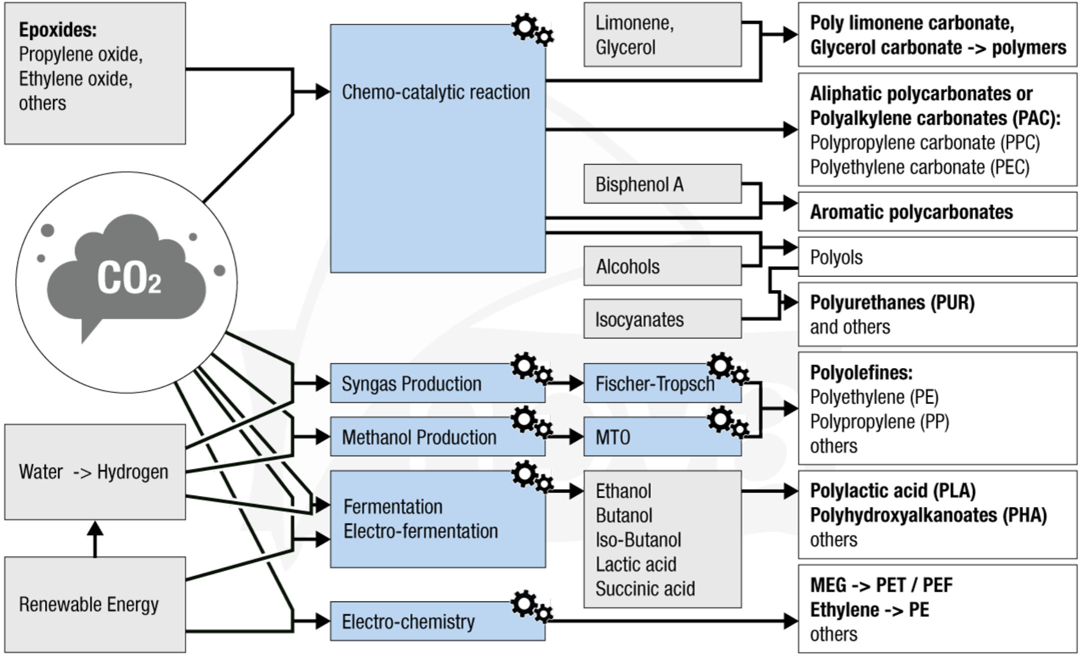
Future of Plastics



- The total of biomass required to do so would amount to roughly 1% of biomass currently used around the globe in all fields of application (13 – 14 billion tonnes, of which 60 per cent alone are attributable to animal feed for the production of milk and meat).
- A size of less than 0.5% of the Sahara desert would suffice to cover this 70 per cent by means of photovoltaics and CO_2 utilisation.



Ways to Use CO_2 for Polymers



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

The only unlimited resource

Renewable carbon is, in comparison to metals and minerals, the only resource, which is practically unlimited: As CO_2 in the atmosphere, which we can make usable with the help of renewable energies or as biomass. That is enough raw material for the next millennia.

- This is the reason why plastics will gain in importance and the age of plastics has only just begun.
- And this is precisely why plastics must become sustainable as quickly as possible and regain a good image.

Political Measures to Support a Quick Transition to Renewable Carbon (see nova paper #10)

- 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 any exceptions or special rules.
  - Recycling, biomass and CO_2 are automatically exempt from the tax.
- **Discontinuation of any funding** programmes in the **fossil** domain.
- **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**)

Survey on “Renewable carbon” in the Chemical Industry

For the first time, we would like to record and present the share of renewable carbon in total carbon use in the 50 largest chemical companies producing in Europe. With this, we want to create awareness that the current fossil raw material base of chemistry has no future. We would like to draw attention to the necessity of the conversion to renewable carbon and show how far the different companies are on this way. Chemistry has to switch to renewable carbon in order not to be the climate sinner in 30 years.

The results are published worldwide as press releases and especially in leading business newspapers. Companies that do not participate are listed at the bottom of the ranking with "no data".

We would therefore like to ask you the following question. **What is the share of the following different carbon sources in the total carbon use in your European production?**

- Fossil in %
- Recycling in %
- Biomass in %
- CO_2 utilisation (with renewable energy) in %

(% based on carbon content)

We support

nova-Institute's campaign on

RENEWABLE
CARBON

CO_2

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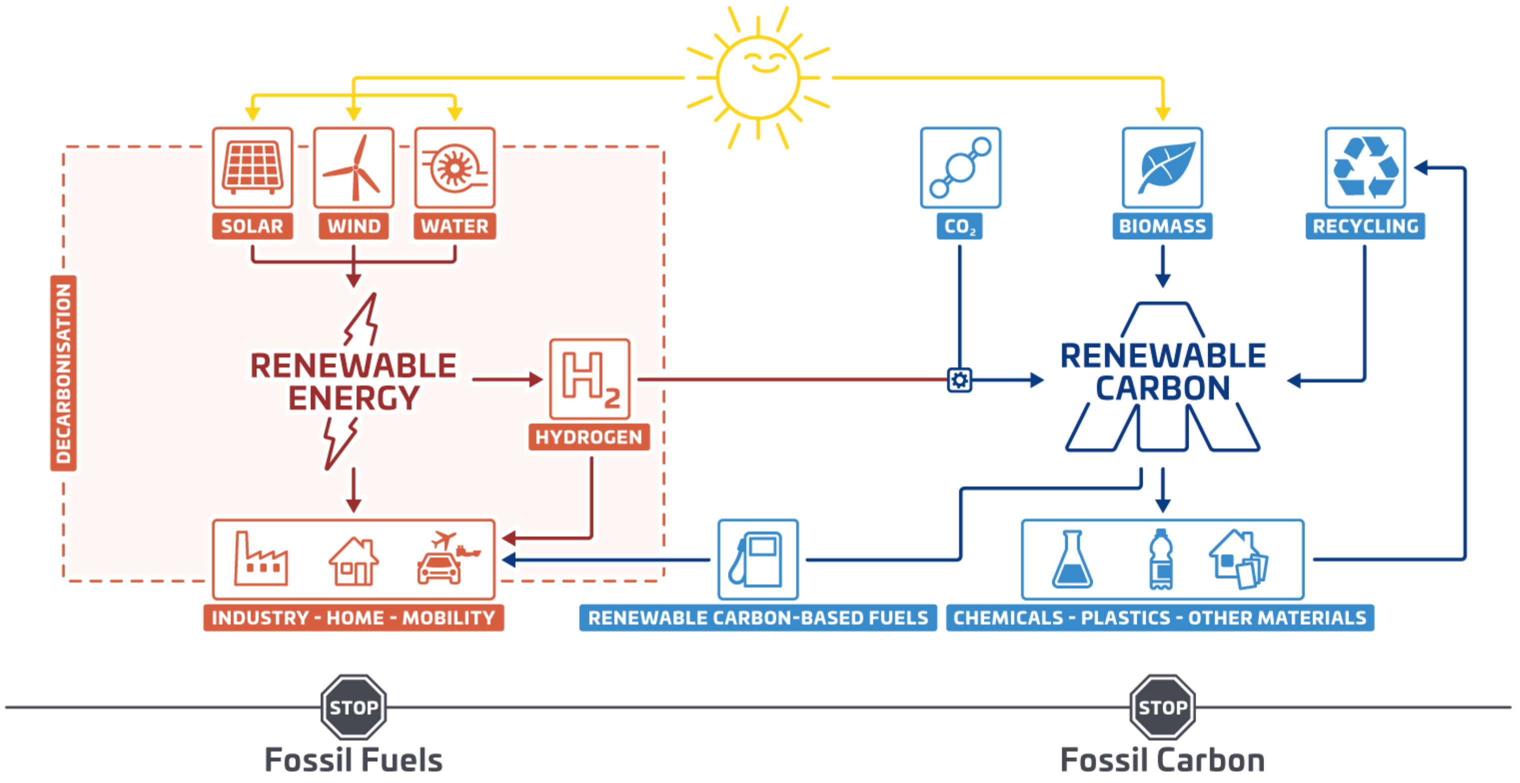
Renewable Energy and Renewable Carbon for a Sustainable Future



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