Renewable Carbon as a Guiding Principle for Sustainable Carbon Cycles

Circular Economy

June 2022

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Shape the future of the chemical and material industry

RENEWABLE CARBON INITIATIVE

renewable-carbon-initiative.com

THE VISION OF RCI

The Renewable Carbon Initiative (RCI) addresses the main cause of anthropogenic climate change by facilitating the transition from fossil carbon to renewable carbon for all organic chemicals and materials. Members of the RCI are pioneers who support the urgently needed acceleration and increase of volume of this transformation.

MEMBERS OF THE INITIATIVE

LARGE ENTERPRISES

ADM, ALPLA, BASF, Beiersdorf, BOREALIS, CLARIANT, Cosun Beet Company, COVATION BIO, covestro, DOW, EVONIK, Firmenich, Givaudan, Henkel, H&R, iff, Lenzing, Lubrizol, MANE, NESTE, pcc, reckitt, SHV ENERGY, stahl, SULZER, TÜV AUSTRIA, Unilever, uniper, UPM BIOFORE BEYOND FOSSILS, VAUDE, Verbio, WACKER

RENEWABLE CARBON INITIATIVE

Bio-based CO_2-based Recycling

... and more than
200 personal supporters

MEMBERS OF THE INITIATIVE

SME

avantium, IBB Netzwerk GmbH, FKuR plastics - made by nature, LanzaTech, nova, TC

START-UPS

BioBTX, clariter, SUNCOAL, TripleW

RESEARCH INSTITUTE

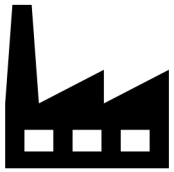
IKT Kunststoff Technik Stuttgart, Leibniz-Institut für Verbundwerkstoffe, NORCE

PARTNERS OF THE INITIATIVE

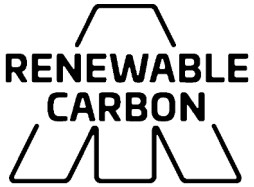
CO_2 VALUE EUROPE, ECBF, Global CO_2 Initiative University of Michigan, GO!PHA Global Organization for PHA, TextileExchange Creating Material Change, WWF

Why are we approaching the Policy Makers?

Backbone of European industry!



Discuss the **future of the chemical and material industry** in Europe



Introduce the idea of **renewable carbon** and how it is the **perfect guiding principle** for a green transition, in line with the European Green Deal and NextGenerationEU

Encourage and advocate policy in order to enable and support the sector's transition

Challenges we want to address with Renewable Carbon

- The chemical industry in Europe is confronted with **massive challenges**

Sustainability

Ukraine Crisis

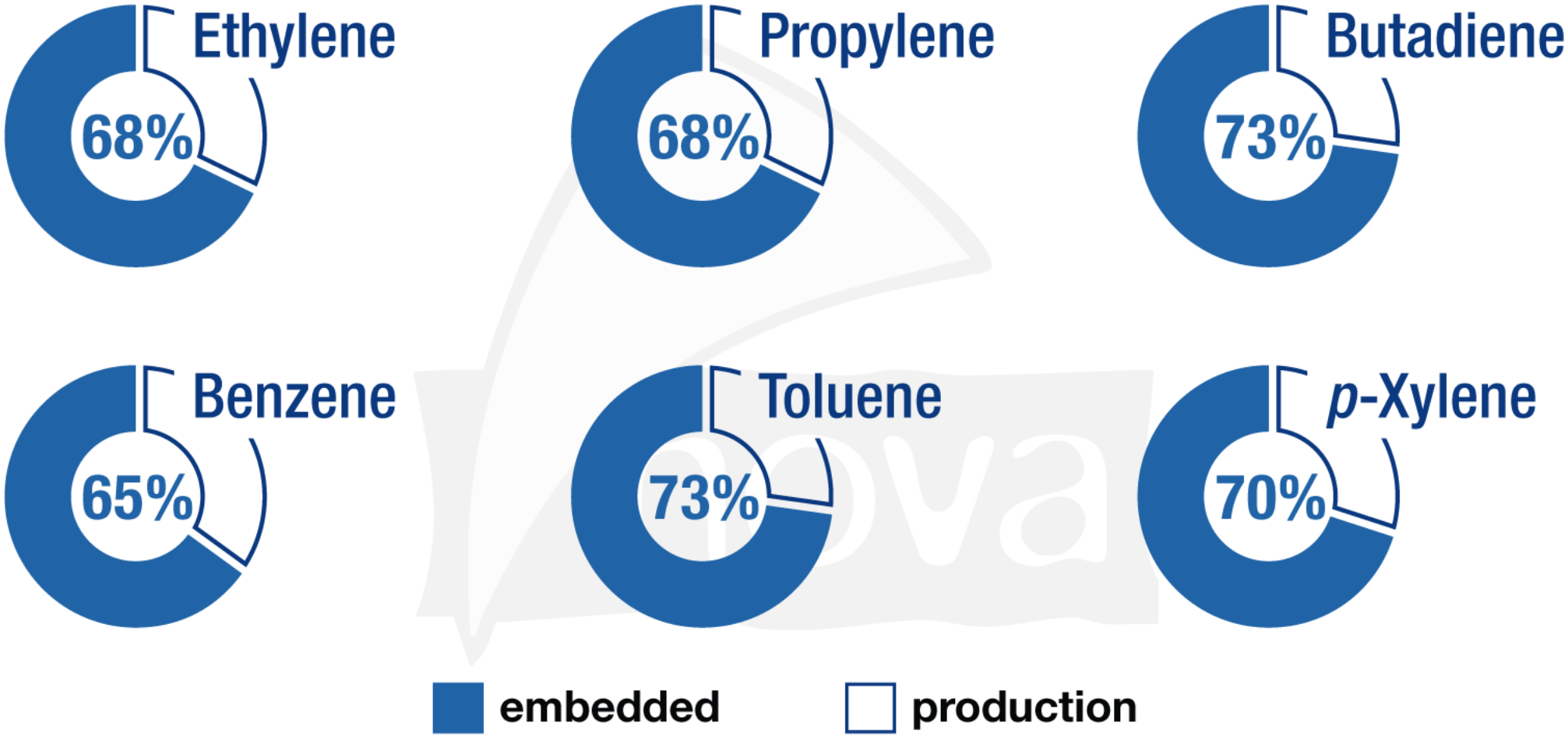
Raw materials and output resilience

Public image and acceptance

Biggest industrial transformation since industrial revolution

The invisible carbon footprint

~2/3 of the GHG footprint of chemicals stems from the carbon embedded in the molecules



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

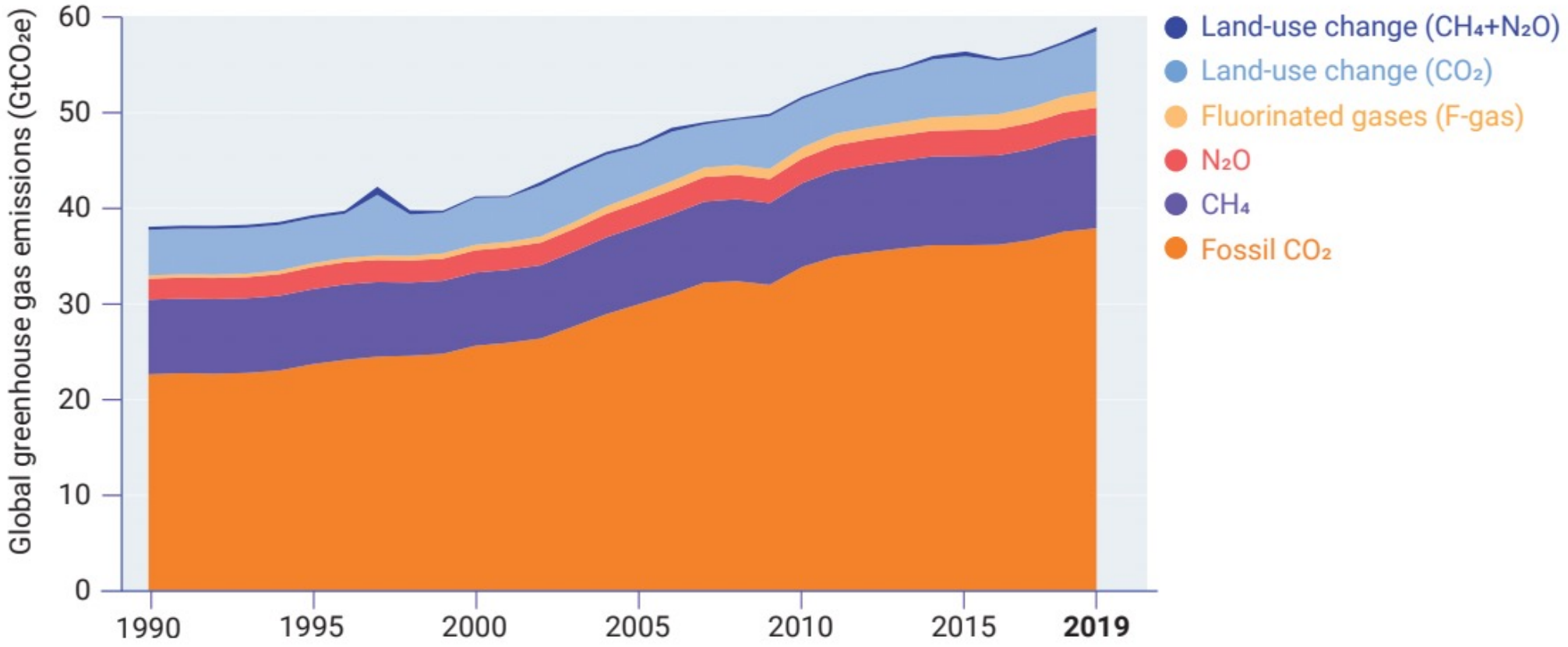
Ethylene, propylene, butadiene – Calculations by nova-Institute
Benzene, toluene, *p*-xylene – Source: BioBTX

Renewable carbon concept on one slide

- **72% from the GHG** emissions come from **additional fossil carbon from the ground**
- **Decarbonisation** with renewable energies is a **good strategy for the energy sector**, but not for chemicals and materials, because most of them are based on carbon (just like humans ☺).
- There is a **lasting and even increasing need for carbon** for chemicals and materials.
- The key challenge is to **cover the demand** for carbon by alternative carbon sources.
- Those alternative carbon sources are **biomass**, **CO_2** 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**".
- The **equivalent to decarbonisation** in the energy sector is a transition to **renewable carbon** in the chemical and material industries. And both mean **defossilisation**.

GHG emissions overview

Figure ES.1. Global GHG emissions from all sources



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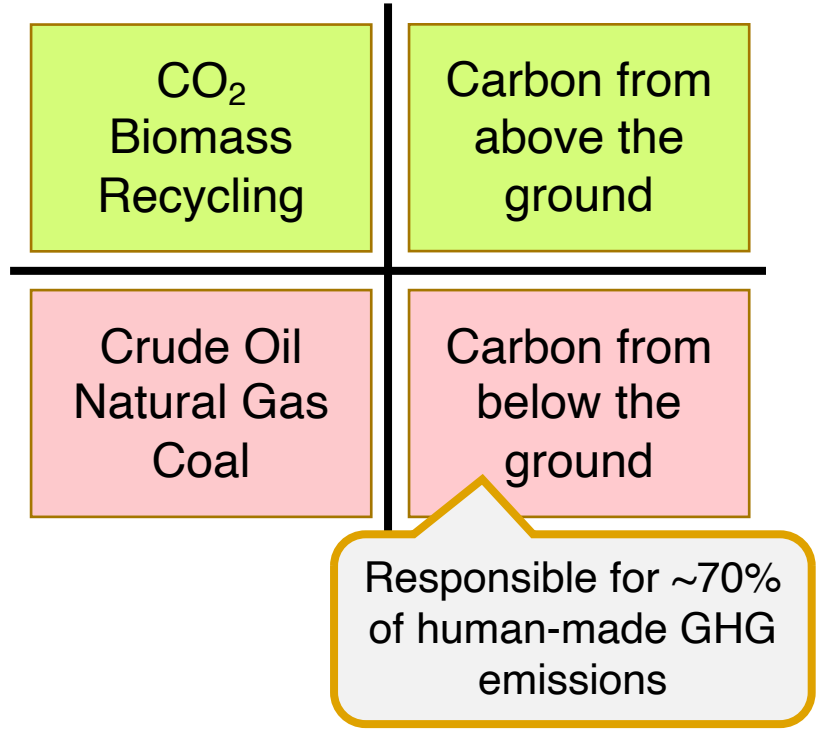
RENEWABLE CARBON

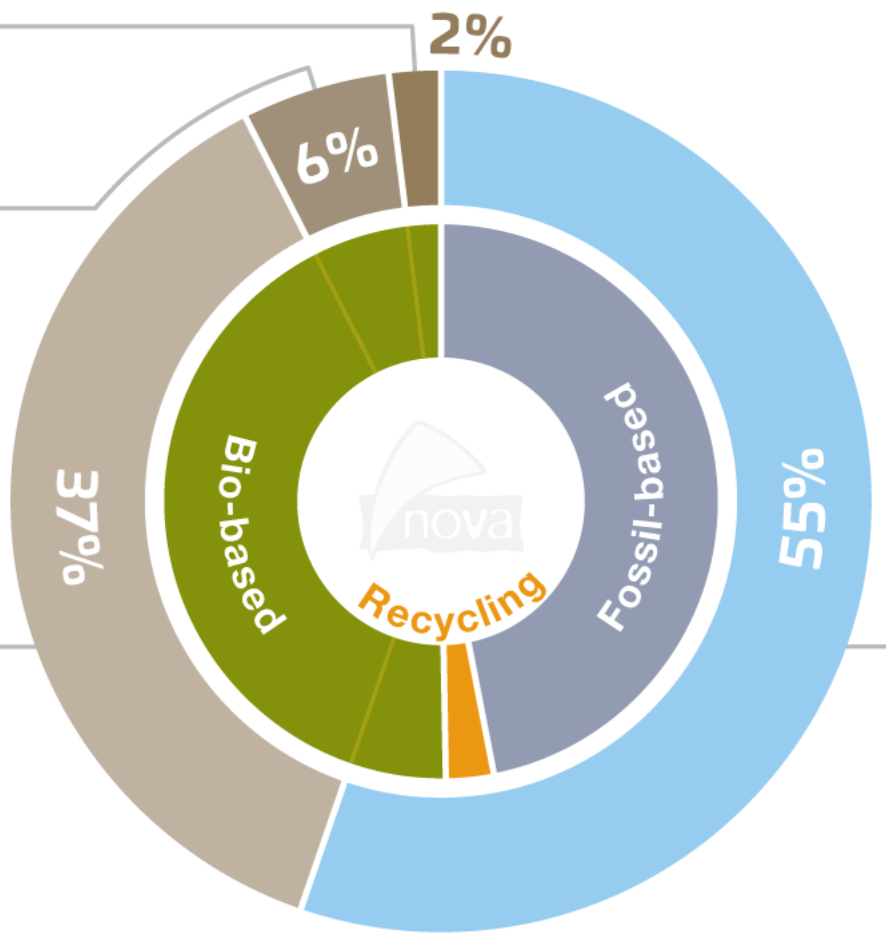
entails all carbon sources that avoid or substitute the use of any additional fossil carbon from the geosphere.

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.



Global Carbon Demand for Chemicals and Materials by Sectors

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



Textiles (natural)
14 Mt embedded C/y

Pulp & Paper
46 Mt embedded C/y

Wood Construction & Furniture
304 Mt embedded C/y

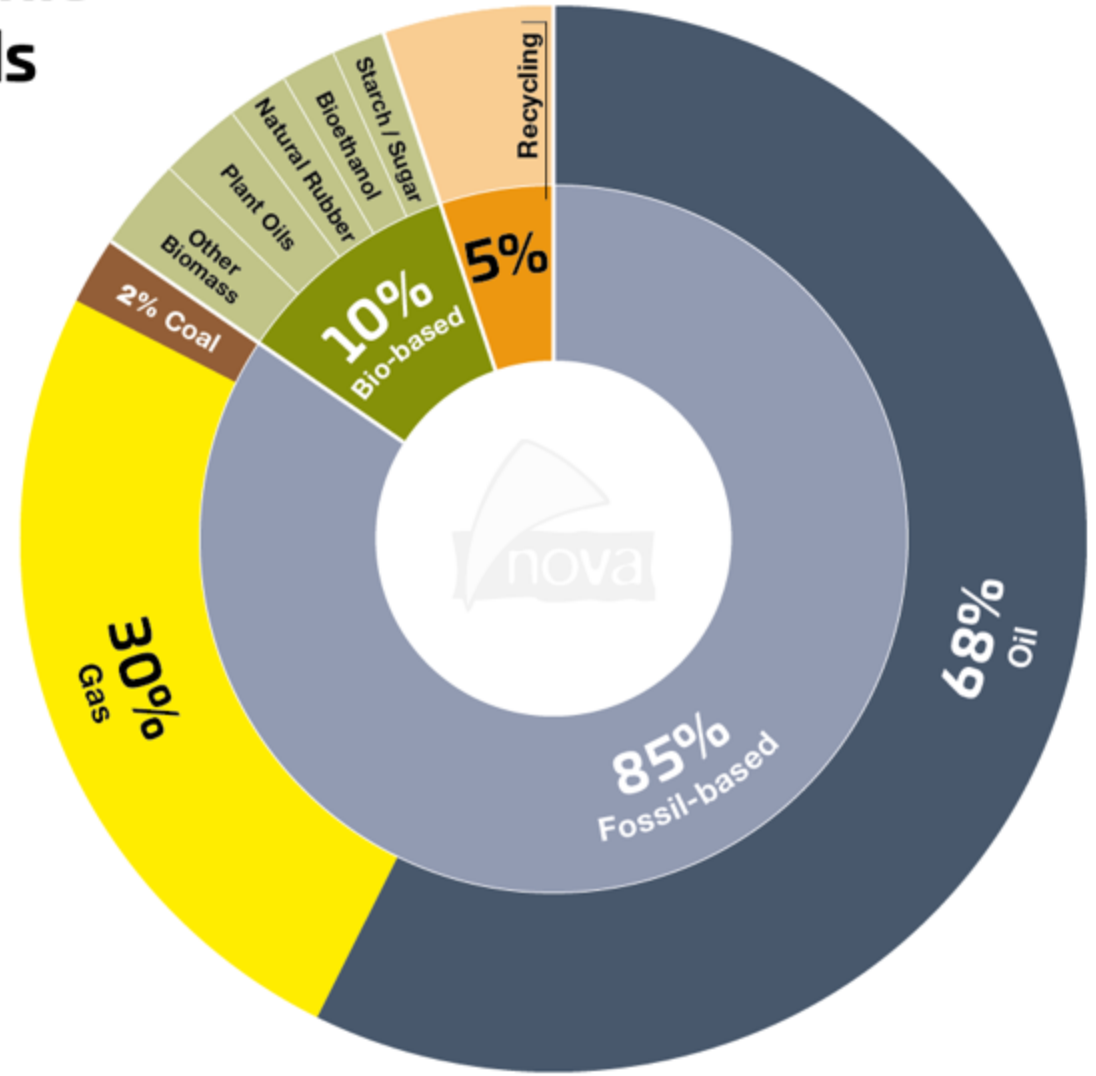
Chemicals & Derived Materials
450 Mt embedded C/y

available at **www.renewable-carbon.eu/graphics**

Global Carbon Demand for Organic Chemicals and Derived Materials

by Type of Feedstock

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



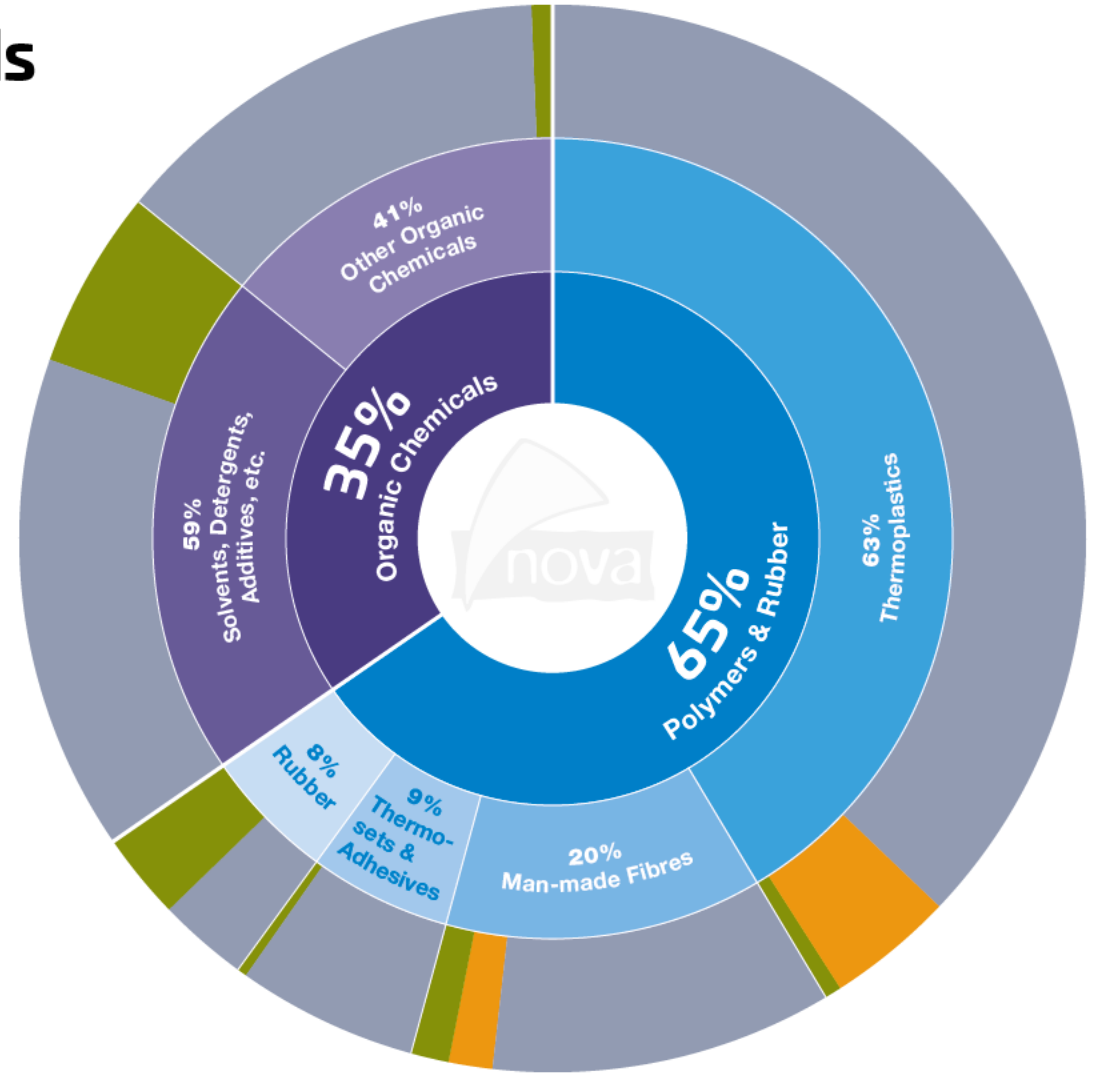
Reference Years: **2015 – 2020**

Main Sources: **Piotrowski et al. (2015), 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**

- Fossil-based
- Bio-based
- Recycling



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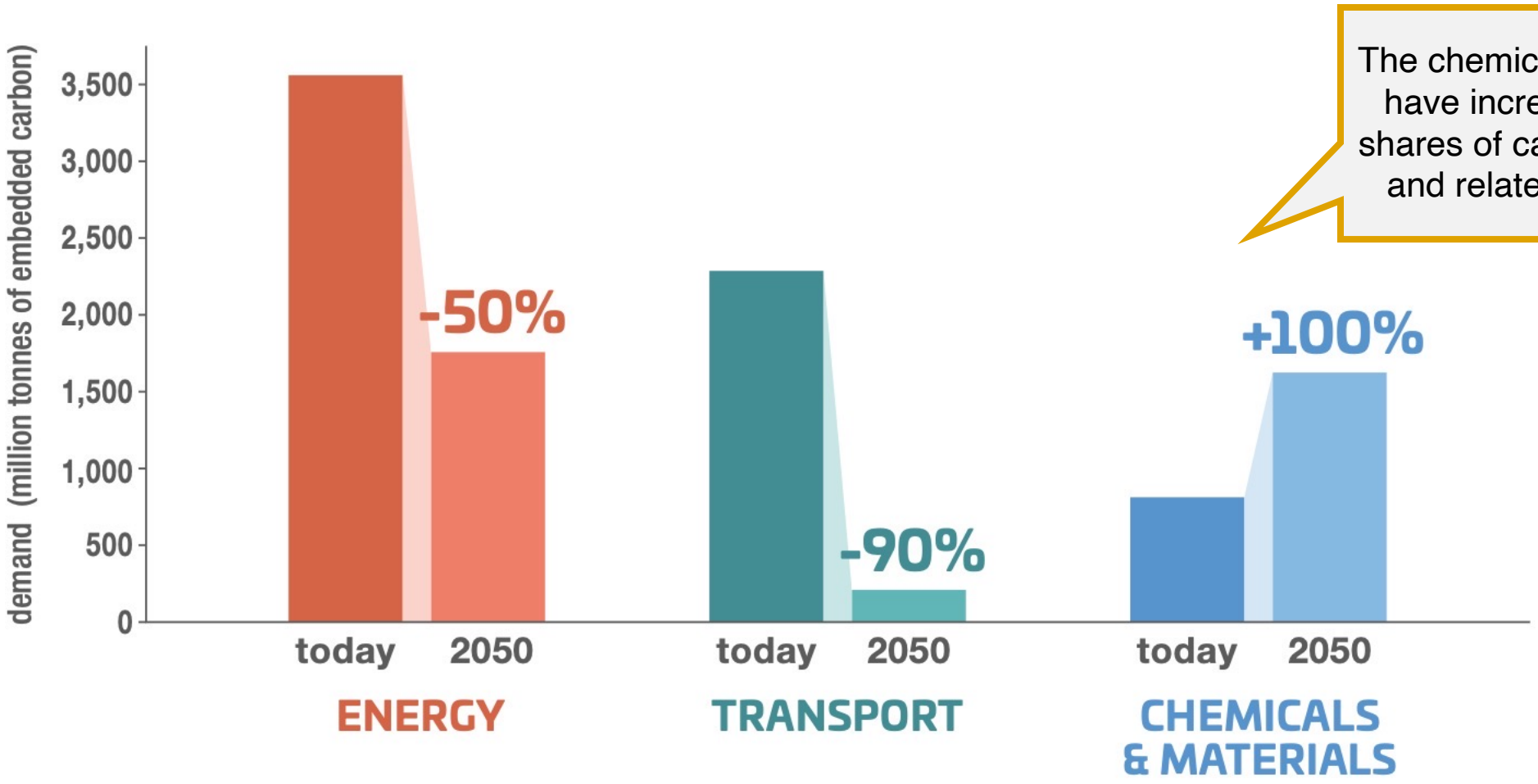
Embedded Carbon Demand for Main Sector

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

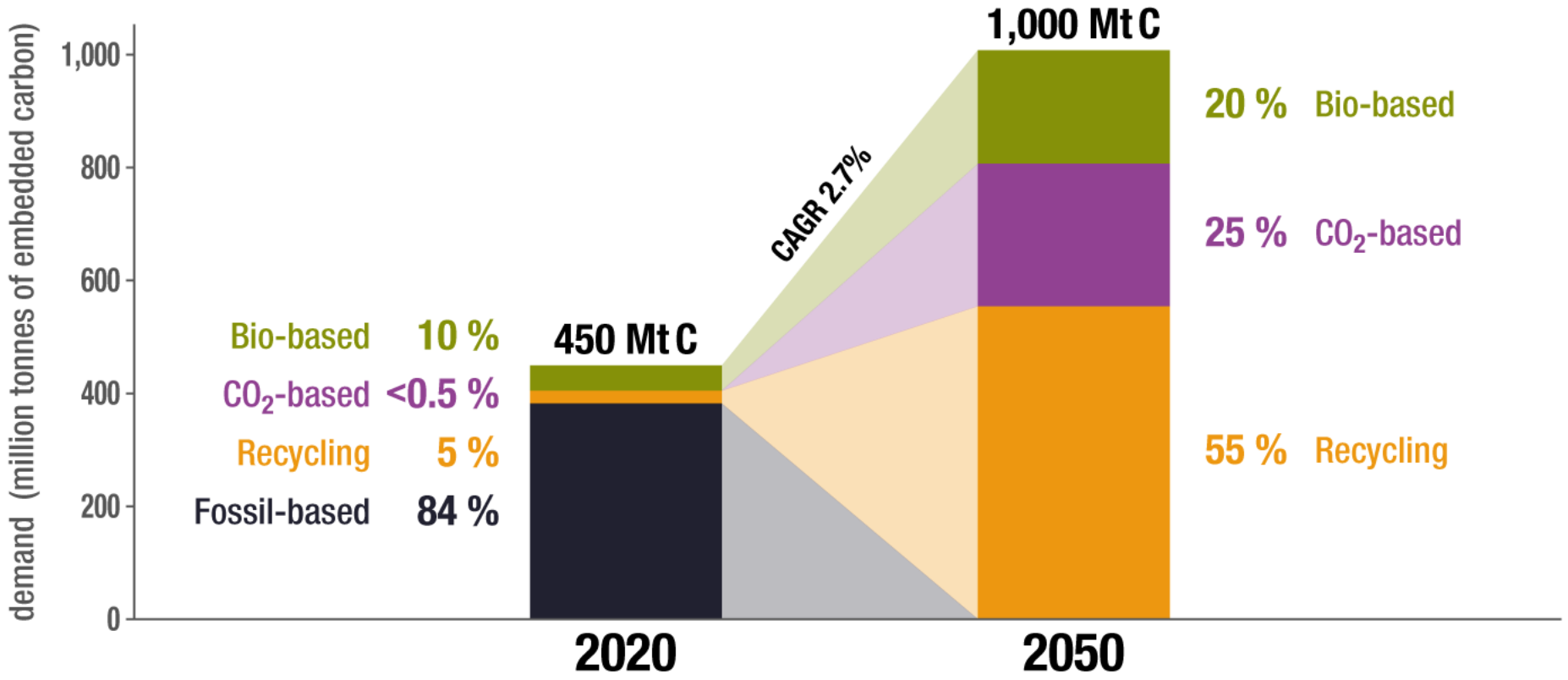


The chemical industry will have increasingly high shares of carbon demand and related emissions

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)



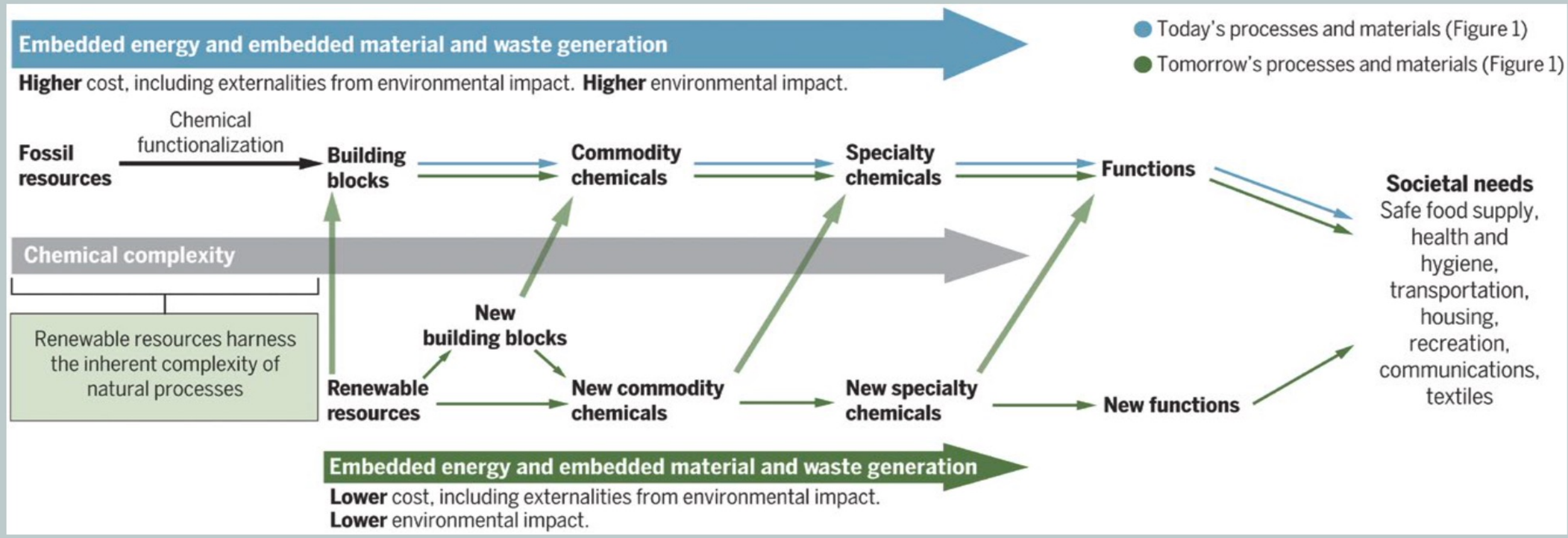
available at **www.renewable-carbon.eu/graphics**

Joel A. Tickner, Ken Geiser & Stephanie Baima (2022) Transitioning the Chemical Industry: Elements of a Roadmap Toward Sustainable Chemicals and Materials, Environment: Science and Policy for Sustainable Development

Figure 1.

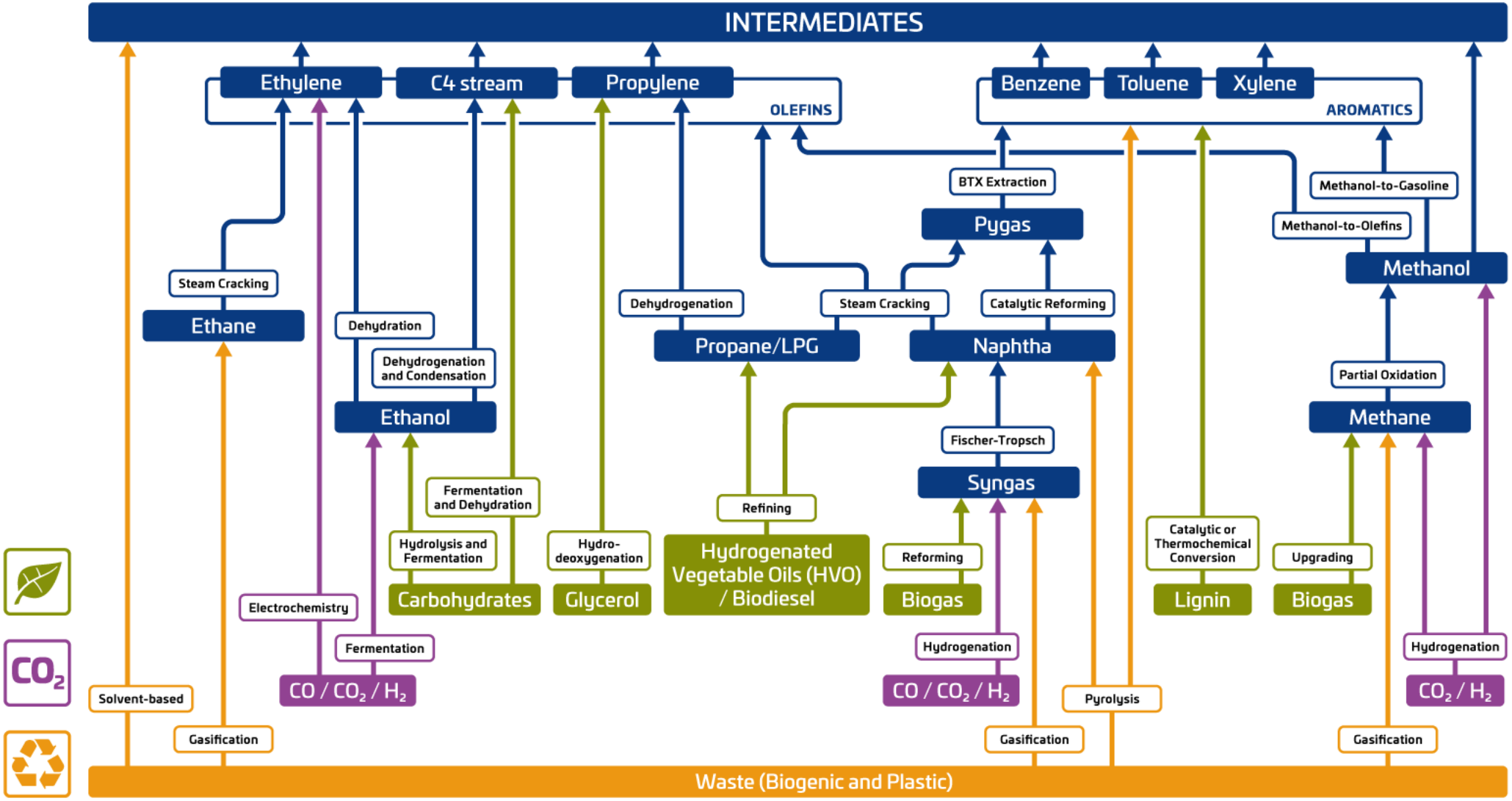
Source: David Gerratt/DG Communications.

Figure 5. The flows of chemical production from fossil resources versus renewable feedstocks.



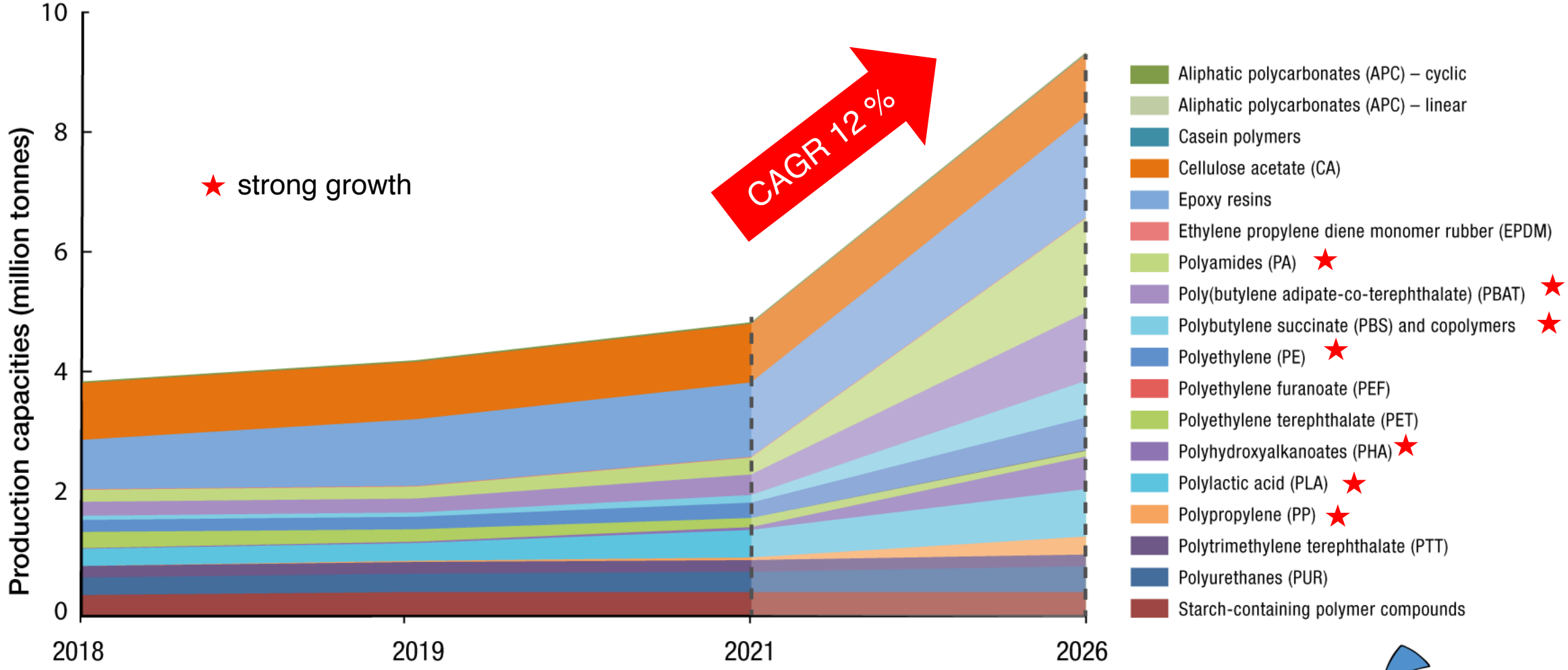
Source: Zimmerman et al., "Designing for a Green Chemistry Future," Science, Jan. 2020, Figure 3.

Renewable Carbon Refinery



available at **www.renewable-carbon.eu/graphics**

Bio-based polymers
Evolution of worldwide production capacities from 2018 to 2026



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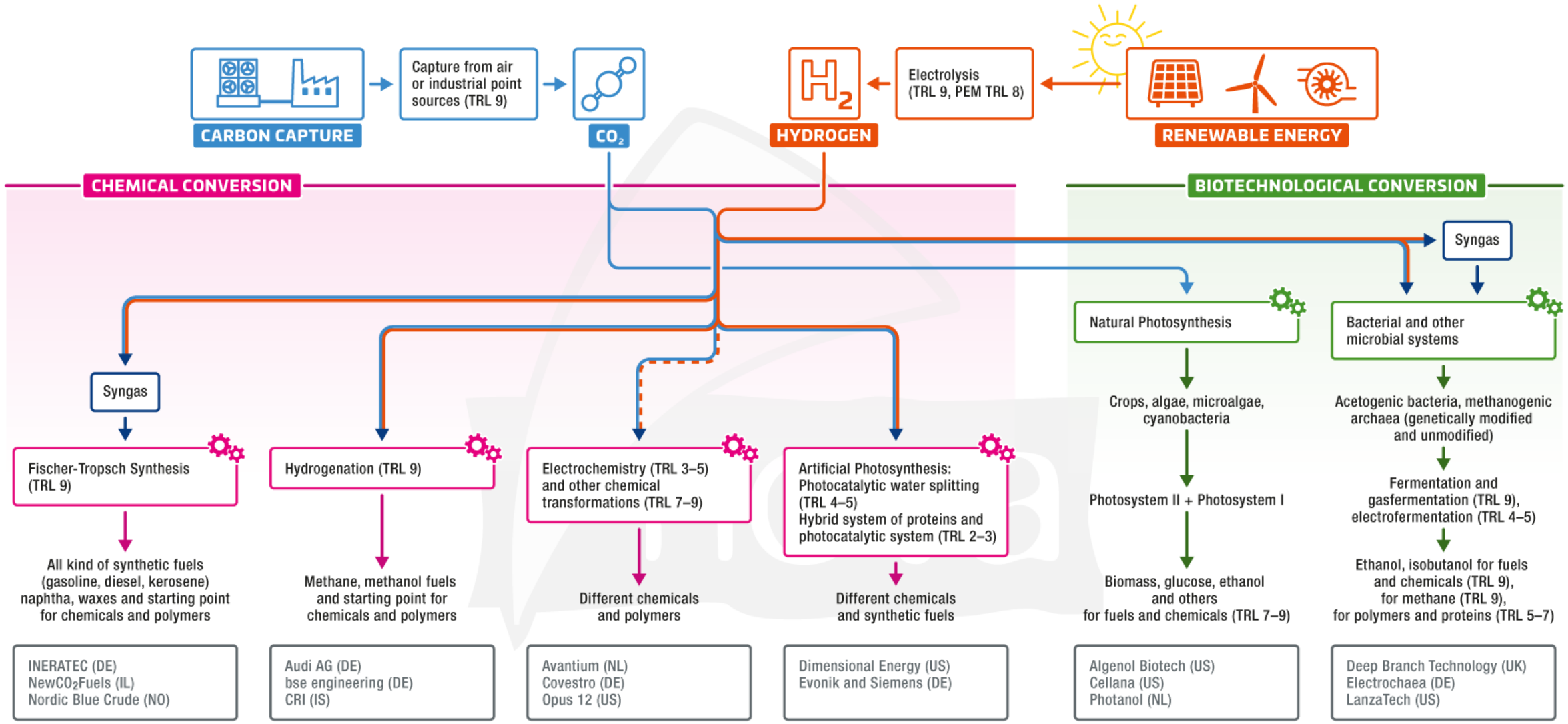
Carbon Dioxide Utilisation and Renewable Energy



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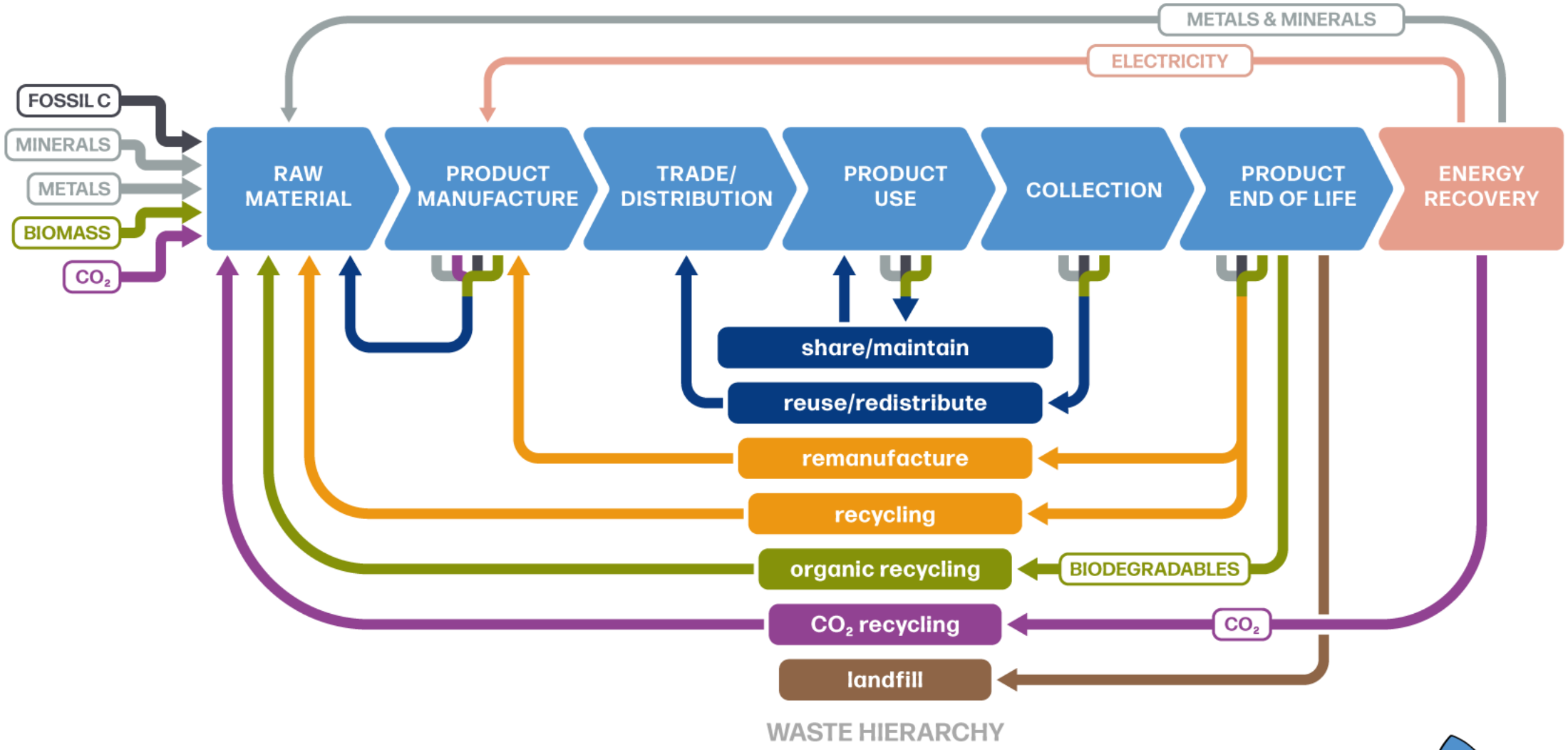
Comprehensive Concept of Circular Economy



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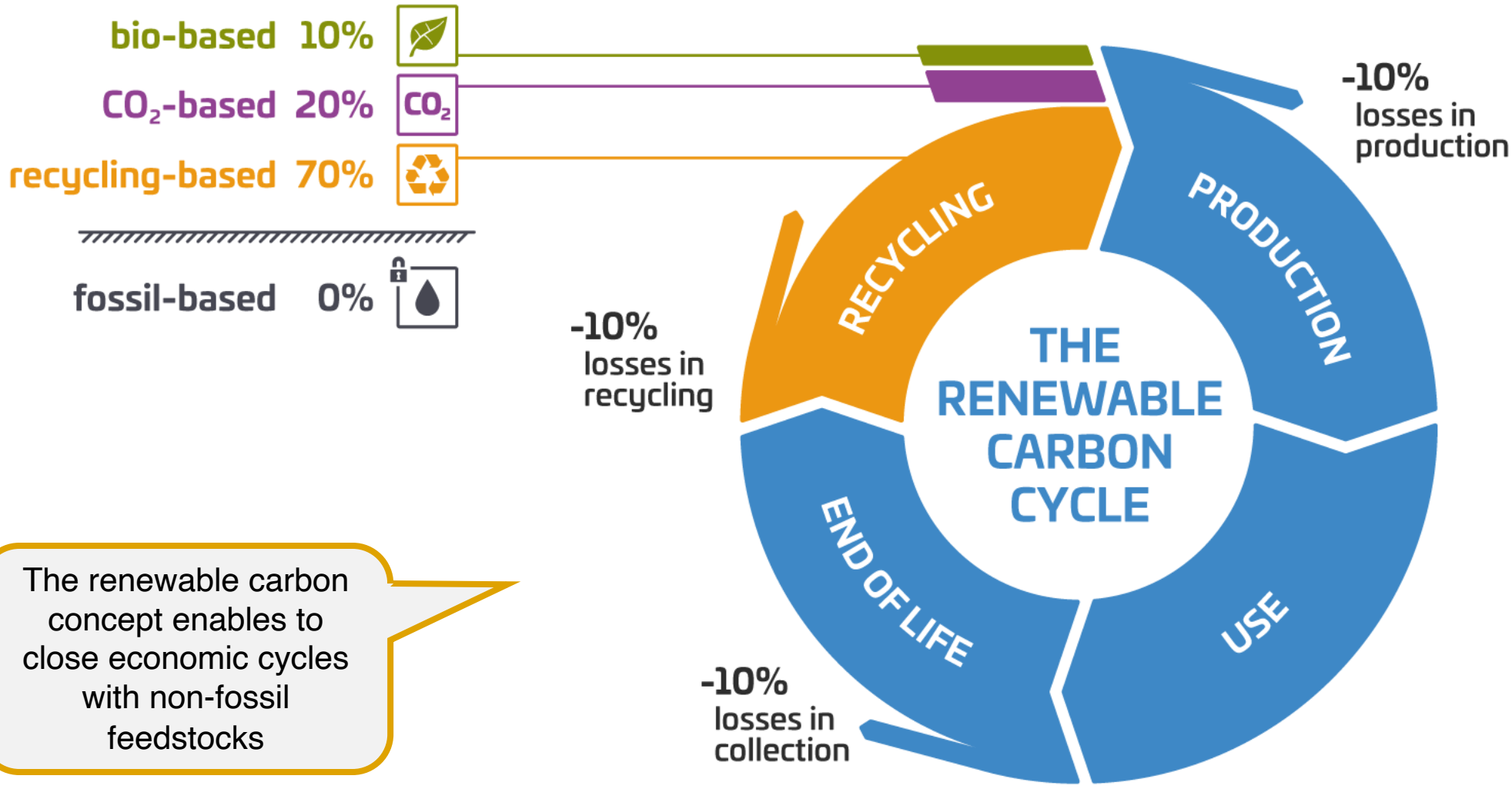
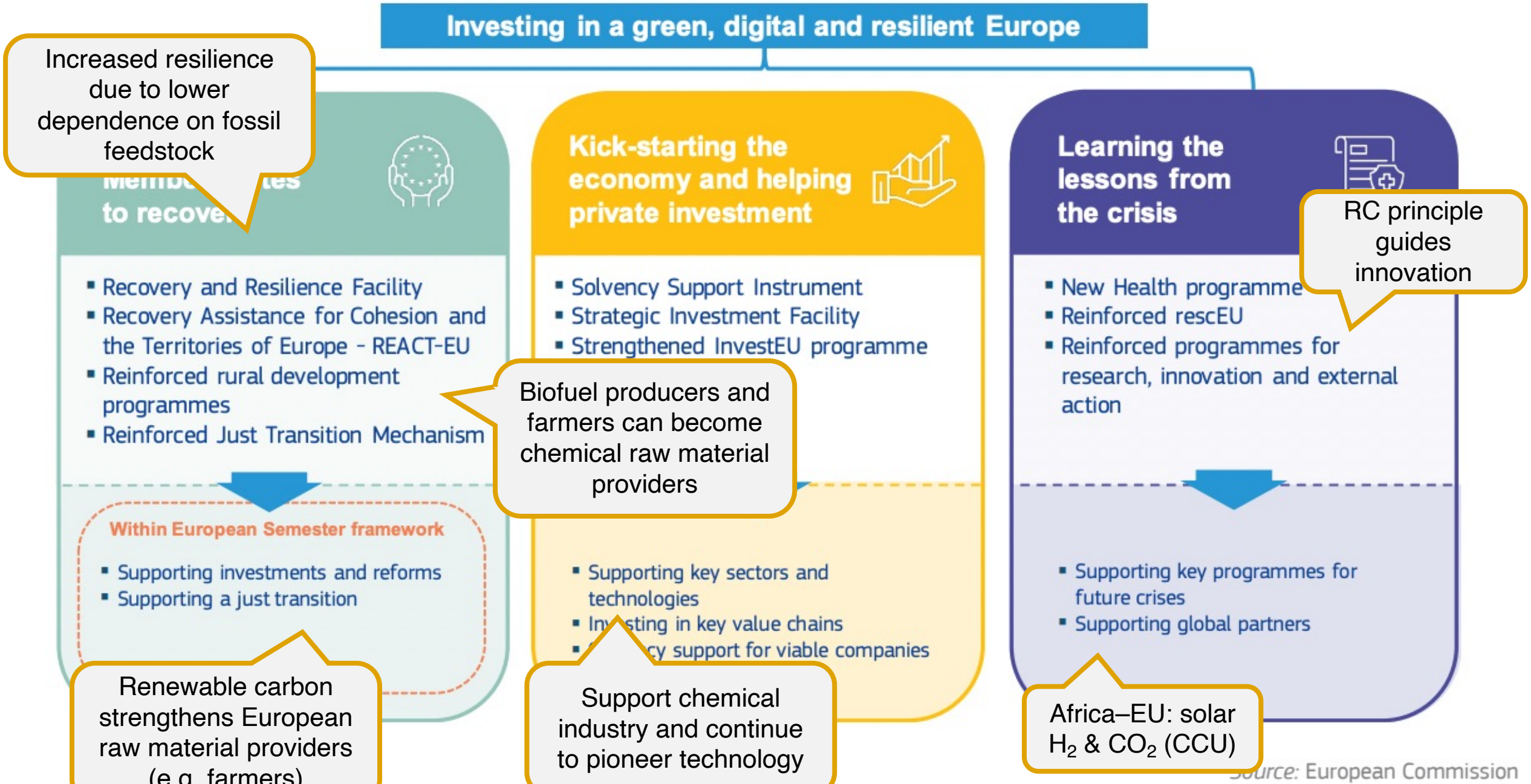
SCENARIO FOR THE PLASTIC INDUSTRY 2050



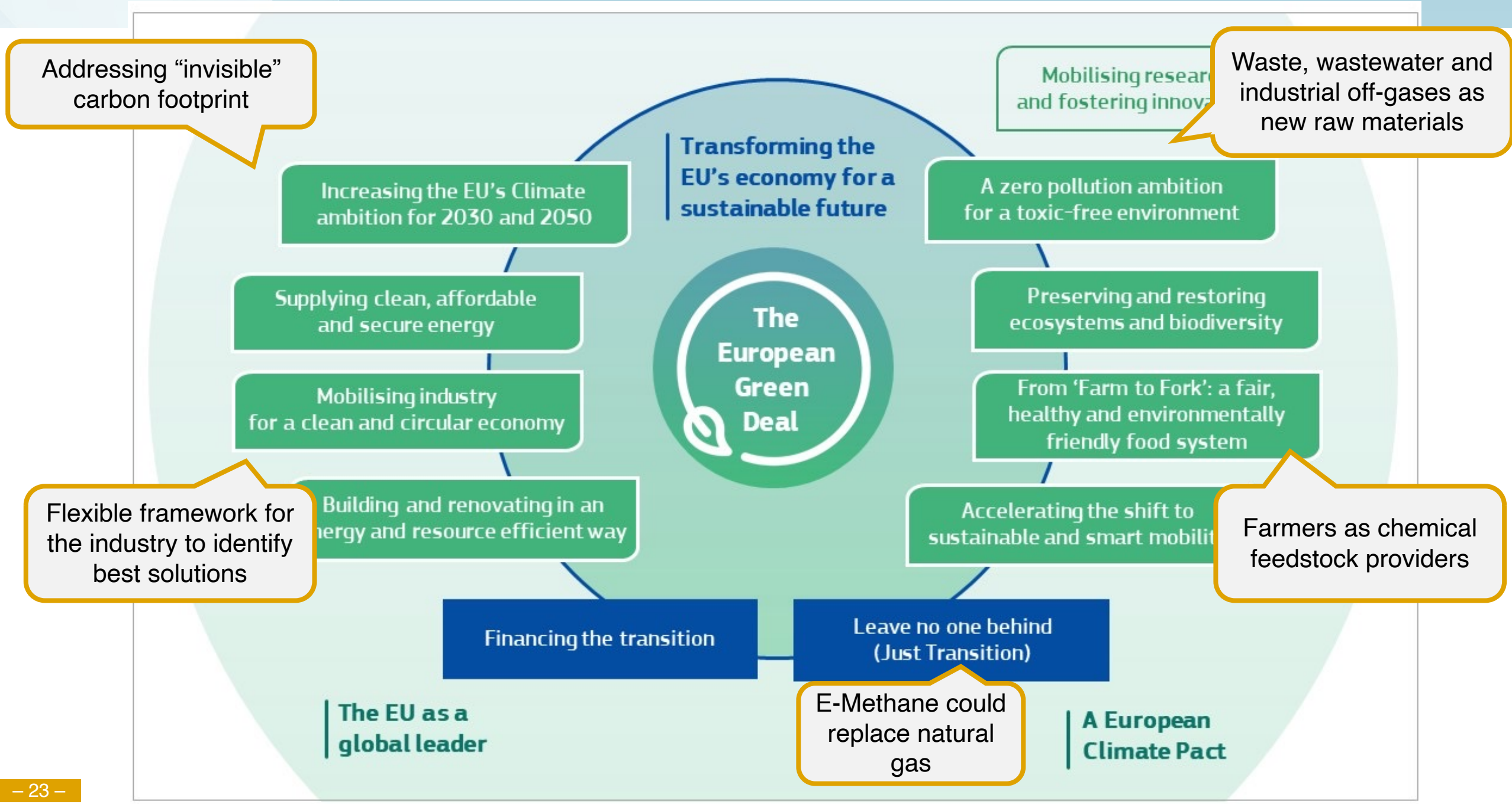
The renewable carbon concept enables to close economic cycles with non-fossil feedstocks

available at **www.renewable-carbon.eu/graphics**

Next Generation EU will be rolled out under **three pillars**:



Source: European Commission


Addressing “invisible” carbon footprint
Waste, wastewater and industrial off-gases as new raw materials
Flexible framework for the industry to identify best solutions
Farmers as chemical feedstock providers
E-Methane could replace natural gas
Transforming the EU’s economy for a sustainable future
The European Green Deal
Increasing the EU’s Climate ambition for 2030 and 2050
Supplying clean, affordable and secure energy
Mobilising industry for a clean and circular economy
Building and renovating in an
ergy and resource efficient way
Financing the transition
Leave no one behind (Just Transition)
Accelerating the shift to sustainable and smart mobilit
From ‘Farm to Fork’: a fair, healthy and environmentally friendly food system
Preserving and restoring ecosystems and biodiversity
A zero pollution ambition for a toxic-free environment
Mobilising researc
and fostering innova
The EU as a global leader
A European Climate Pact

Now is a historic opportunity to shape the future of the chemical industry

Pressure from **climate change**

- Conformity with the goals of the **Paris Agreement**
- **Public** attention
- Science-based targets

The **economic landscape and demand for** (usually fossil-derived) **carbon** is **changing drastically**

energy and transport

chemicals and materials

Large **refineries** are currently planning heavy **adaptations**

15% of feedstock into chemicals today → 80% of feedstock into chemicals in 2050

Big opportunity to support a shift to renewable feedstock!

Desire to become **less dependent on fossil fuel** exporting countries

- Locally sourced feedstocks
- Upscale African-European cooperation (solar energy)

RENEWABLE CARBON INITIATIVE

What we are advising for (1/3)

Carbon as a feedstock has been politically ignored until now

Renewable carbon & carbon management must become integral parts of policies and targets:

Utilise the **renewable carbon concept as guiding principle** for sustainable development in the chemical and material sector

Overarching transformation strategy for this historical transformation of chemicals and materials to renewable carbon

Decouple the petrochemical industry from petro

Comprehensive **political support**, design and backing for this transformation

Level playing field between energy and chemicals & materials, harmonisation between different DGs

What we are advising for (2/3)

Support the transformation of the chemical industry in particular through:

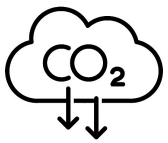
Maintain and strengthen the existing chemical infrastructure (in particular the large chemical refineries and verbund sites) by supporting and steering the transition (e.g. include CCU in supportive regulation)

Massively expand **renewable energy and green hydrogen** grids, “Marshall plan” for a high volume production of PV in Europe

Consider **supporting actions for market access** (like quotas) to help scale-up products based on renewable carbon

What we are advising for (3/3)

Think long-term and **consider sustainability and climate targets**:



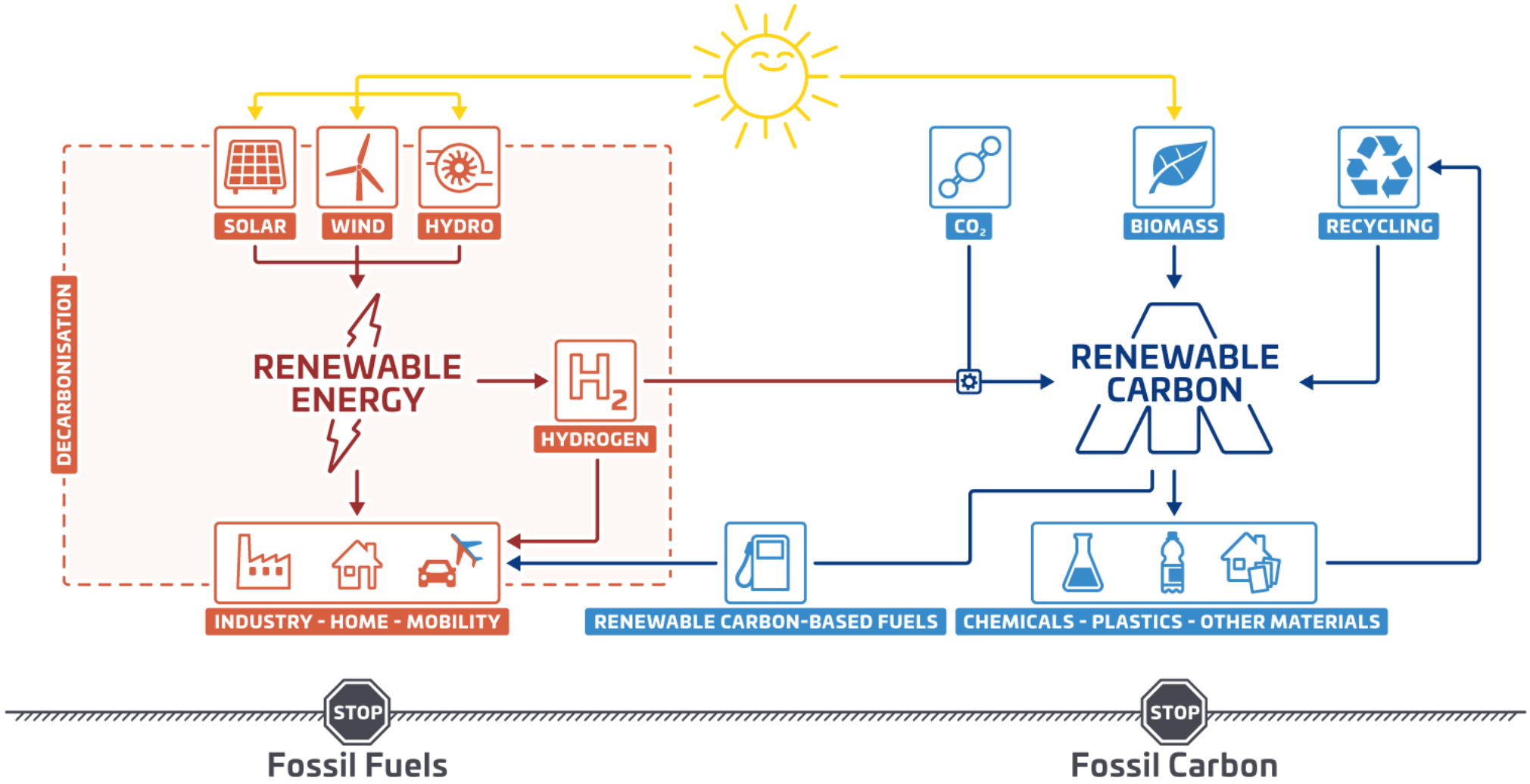
CCU with renewable energy is a highly feasible C-feedstock for the industry. **Include CCU in policy and regulation** so required innovation and development can happen

Consider a possible **transformation of the biofuel value chain** into a chemical supplier value chain

Include **scope 3 emissions** in climate policy to truly become carbon-neutral

Openness towards and acceptance of new technologies and concepts such as **chemical recycling** and the **mass balance approach**

Renewable Energy and Renewable Carbon for a Sustainable Future



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

RENEWABLE CARBON INITIATIVE

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> **Shape the Future of the Chemical and Material Industry**

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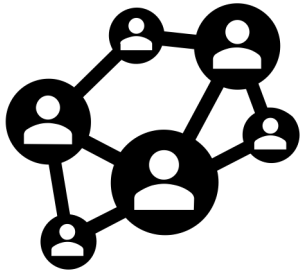
Activities of the RCI

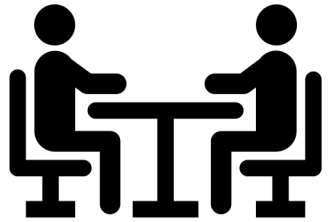
- **Outreach activities to make RCI and the RC concept better known**
  - **Website**
  - **Webinars and Presentations**
  - **Press releases**
  - **Library** (with presentations, graphics, comics)

- **Networking and Exchange between members**
  - **Renewable Carbon Community** platform
  - **2 annual meetings / year** (1 online, 1 on-site)
  - Quarterly **internal newsletter**
  - Many activities between member companies have been initiated after they joined RCI



Activities of the RCI

- **Workings Groups with all involvement of members**
  - **Policy** → Policy factsheets, position paper, short-term response to public consultations
  - **Labelling** → Development of Renewable Carbon Share (RCS) Certification & Label
  - **Sustainability** → Just kicked off, initially looking at LCA methodology (PEF, JRC recommendations, harmonisation)
  - **Recycling** → to be kicked off in June
  - Further groups are always possible

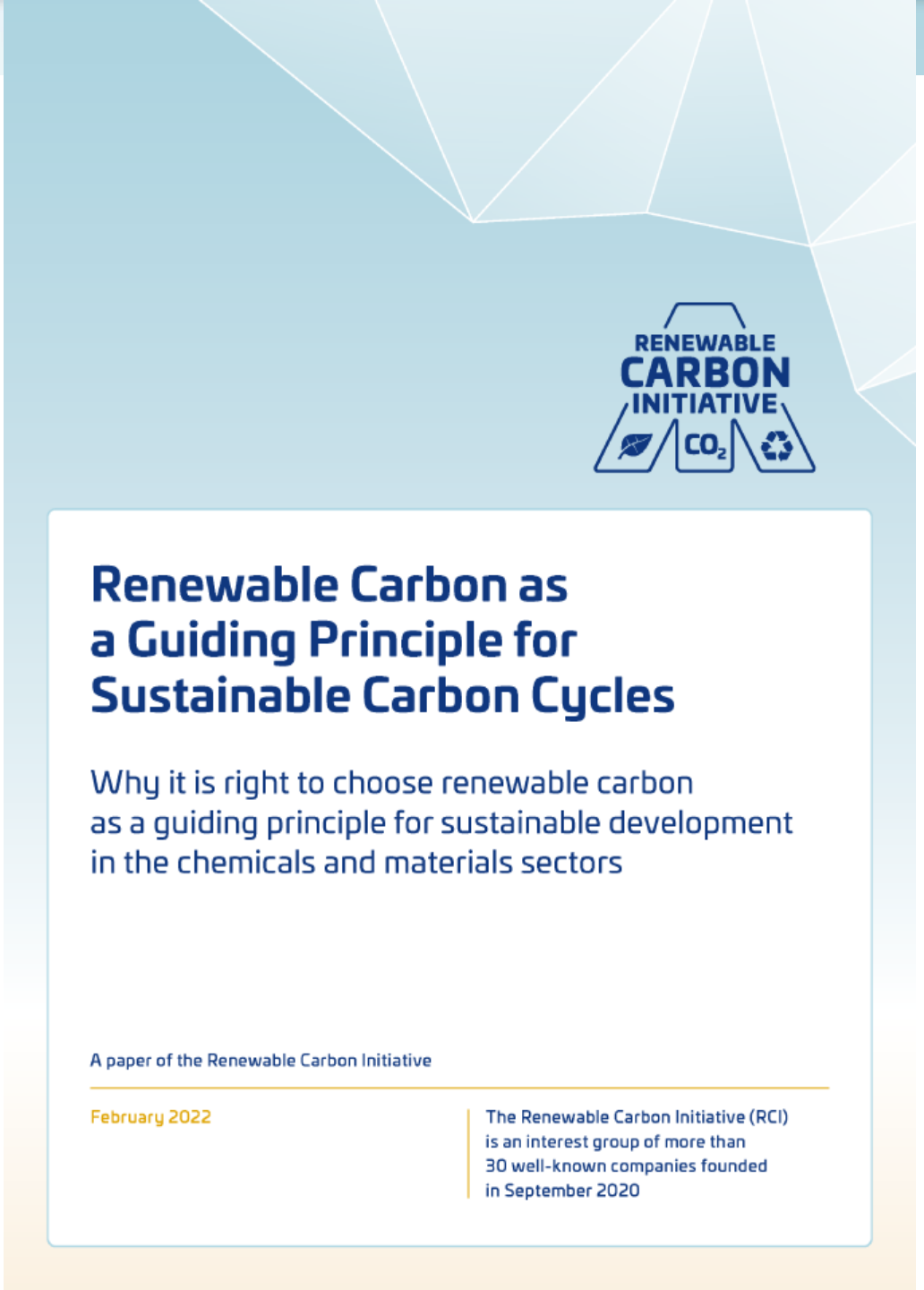


- **Advocating the RC concept to policy-makers at EU level**
  - Connecting with **relevant stakeholders** in Brussels
  - **Visits to several DGs, EP, main associations**
  - Under consideration: RCI Workshop(s) with member in Brussels
  - Increasing participation in feedback processes, public consultations, stakeholder meetings, etc.

Work flow within RCI

- **Providing background information, literature and knowledge**
  - Paper on **Renewable Carbon as Guiding principle for Sustainable Carbon Cycles**
  - **Different high-level reports** on the mitigation potential of CCU with renewable energy, Carbon Flows in the World and in Europe, LCA (JRC methodology on alternative plastic feedstocks), CCU vs. CCS vs. PV, Food vs. Non-Food
  - **Fact sheets on different regulations** with impact on renewable carbon
  - **Definitions and Glossary** on the website

- **Scientific reports**
  - **Usually led by nova** → Preparing the general scope, draft, realisation and final layouting of the report
  - **Members are involved** throughout the steps (e.g. via the working groups, if a specific topic fits to a working group) → Involvement ranges from very active members to members that are just happy to be onboard

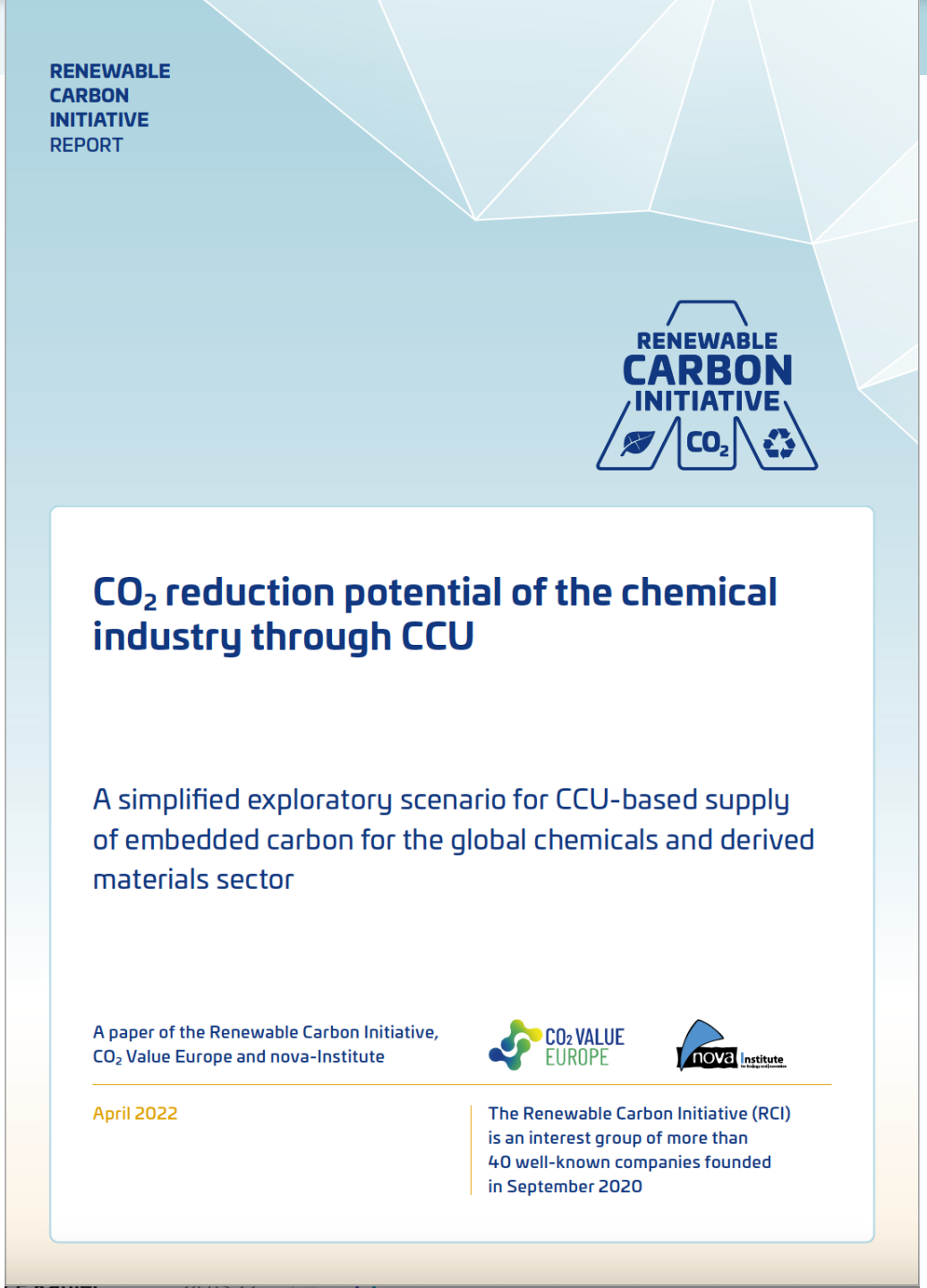


vom Berg, C. and Carus, M. et al. 2022:

Renewable Carbon as a Guiding Principle for Sustainable Carbon Cycles.
41 pages.

Editor: Renewable Carbon Initiative (RCI)

Febr. 2022. Available at: www.renewable-carbon-initiative.com



Kähler, F. and Carus, M. et al. 2022:

CO_2 Reduction Potential of the Chemical Industry Through CCU.
28 pages.

A combined paper of RCI, CO_2 Value Europe and nova-Institute

Will be **published in May 2022**.

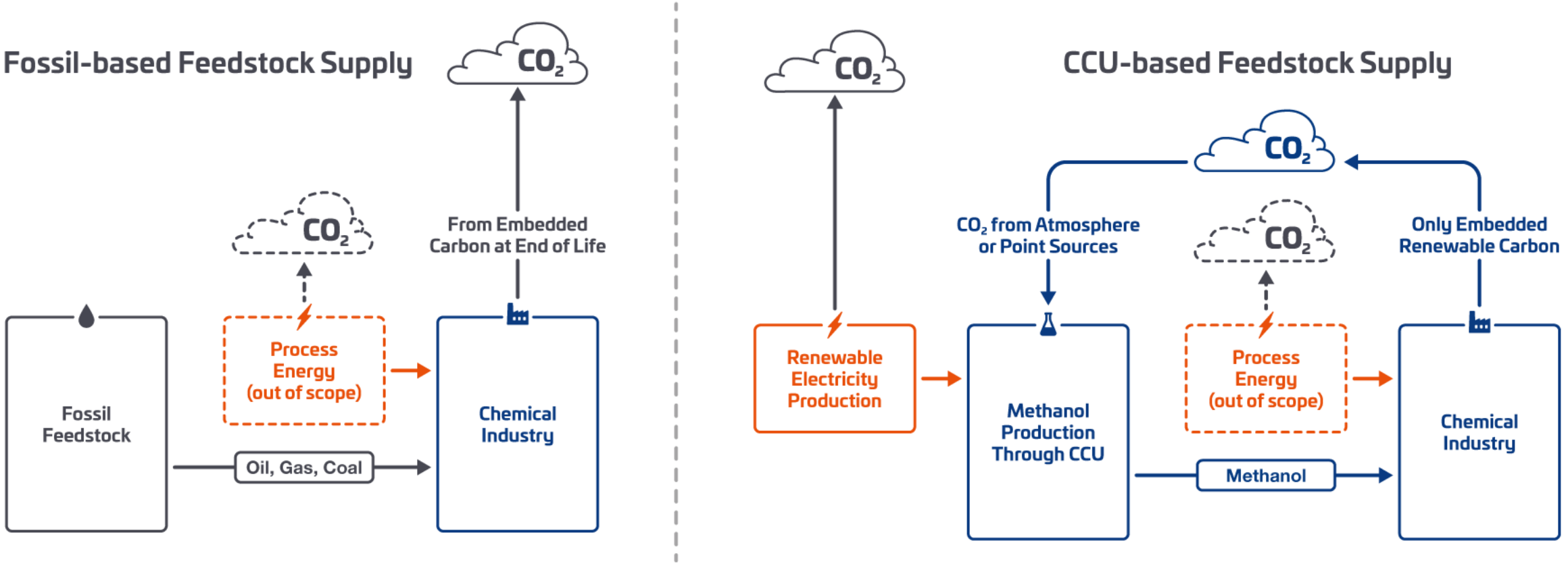
Available at:
www.renewable-carbon-initiative.com

Energy demand for carbon capture

Source of CO_2	Details	Reference	Energy demand per 1 t of CO_2 (Heat + Electricity)
Point source, pure CO_2	Ammonia plant	(von der Assen et al. 2016)	114 kWh
	Bioethanol fermentation plants	(Müller et al. 2020)	120 kWh
Point source	Market pulp mills	(von der Assen et al. 2016)	286 kWh
	Coal power plant	(von der Assen et al. 2016)	339 kWh
	Gas power plant	(von der Assen et al. 2016)	444 kWh
	Integrated pulp and paper mills	(von der Assen et al. 2016)	447 kWh
	Cement	(von der Assen et al. 2016)	956 kWh
Direct air capture, future	Temperature-vacuum swing adsorption	(Deutz and Bardow 2021)	1111 kWh
Direct air capture	-	(von der Assen et al. 2016)	1522 kWh
	Temperature-vacuum swing adsorption	(Deutz and Bardow 2021)	2006 kWh

- Assumption: 1,000 kWh / t CO_2 (DAC + point sources)

CO_2 Emissions From Embedded Carbon in Chemicals



available at **www.renewable-carbon.eu/graphics**

Emission Reduction Potential for Replacing Fossil Feedstock with CCU-based Methanol

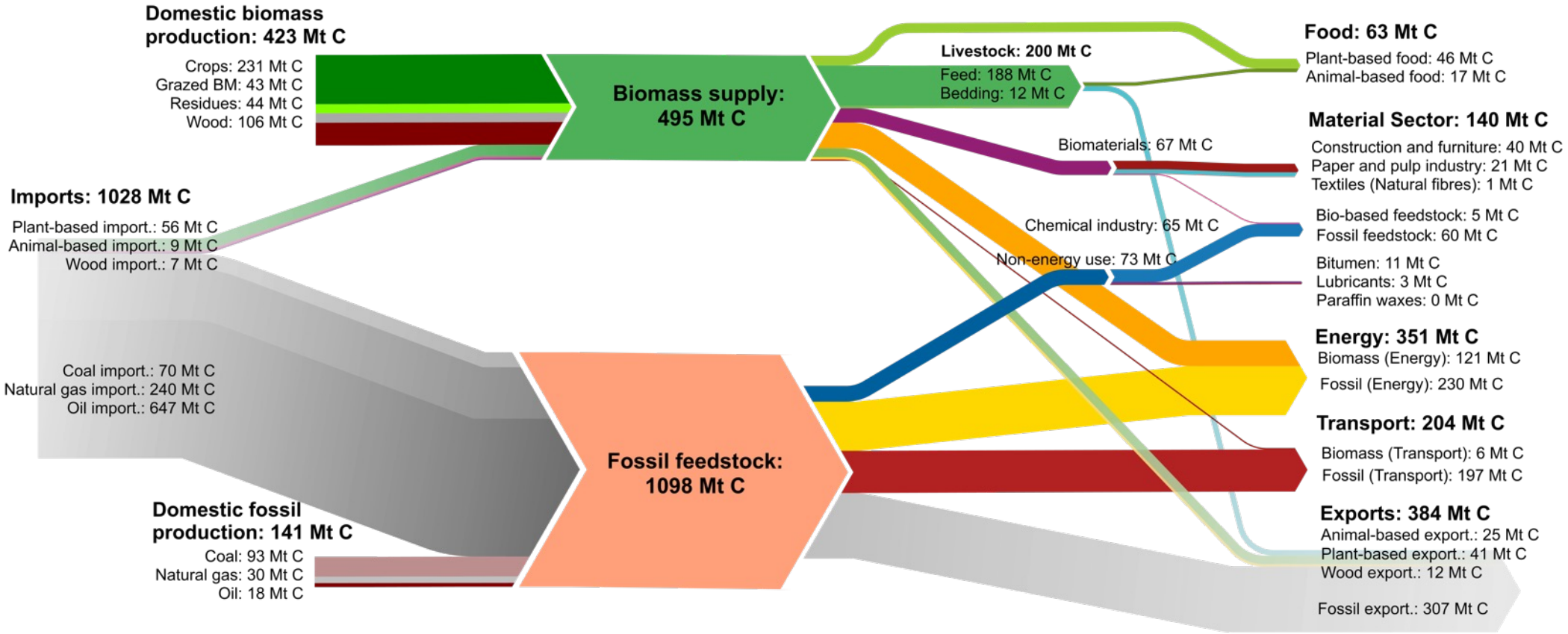
available at **www.renewable-carbon.eu/graphics**

Absolute electricity demand and emission reduction potential

- Global carbon demand today: 450 Mt C (embedded carbon for chemicals)
- 2050 scenario: 1,000 Mt C
- To supply 1,000 Mt C
  - 10,900 kWh / $t_{methanol}$
  - 29 PWh_{el} / year is required
  - 117,000 km^2 desert area is required
  - **1.3% of the Sahara** desert
- Using completely decarbonised renewable energy, the reduction potential is **3.7 Gt CO_2 / year**
- Global CO_2 emissions today: **55 Gt CO_2 / year**

Carbon flows in the EU-27 economy

Biomass and Fossil Resources, Recycling and CCU to be included



Total supply: 1664 Mt C

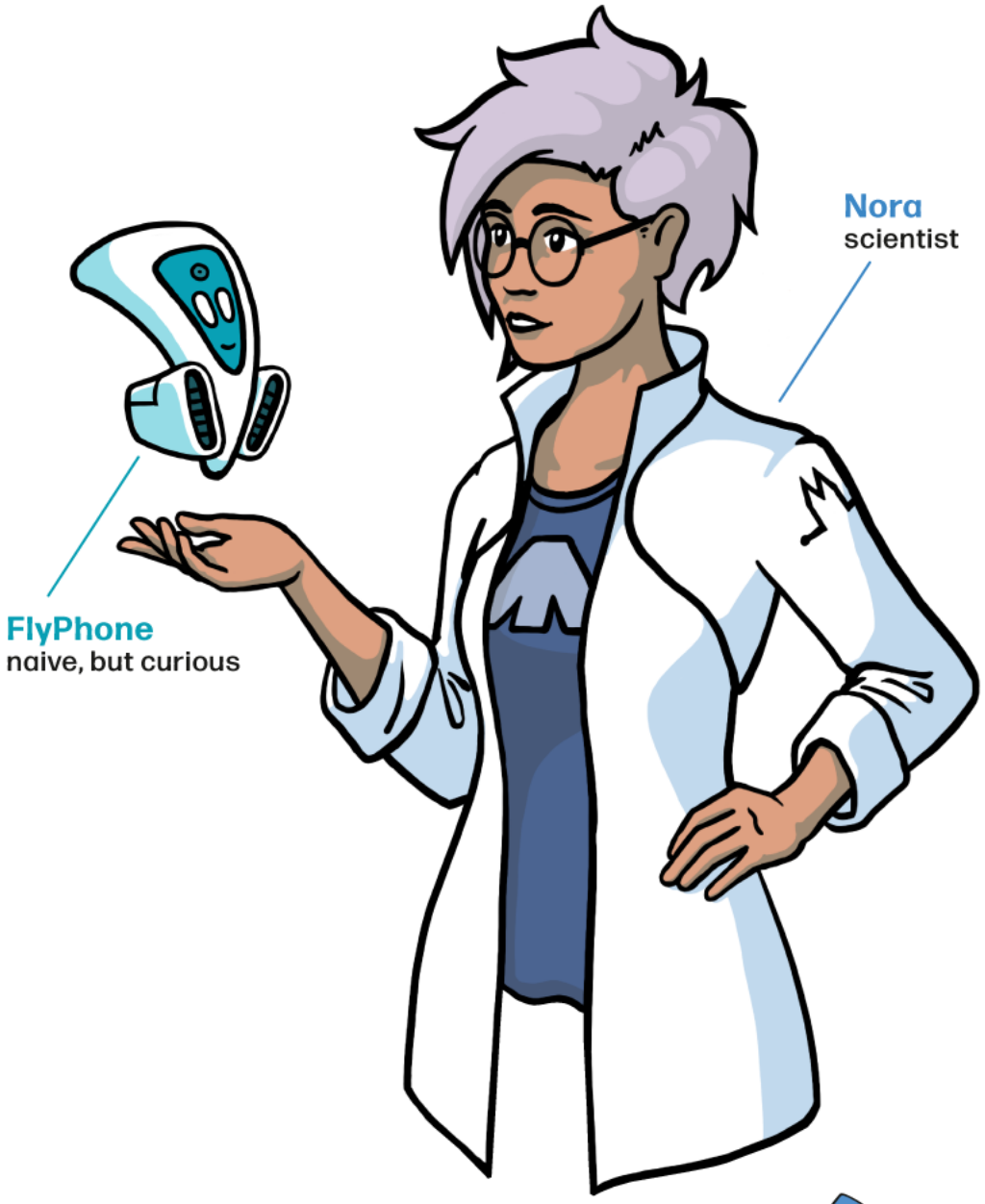
Total demand: 1343 Mt C (including export)

The RCI/CVD/nova report on carbon flows will be published after the summer break

Reference year: 2018
Differences in Supply and Demand due to losses and data inconsistencies
Sources: nova-Institute, Eurostat (2022), JRC (2022)

NORA
AND HER FLYPHONE

ON
RENEWABLE CARBON



available at www.renewable-carbon.eu/graphics

Text: Michael Carus and Christopher vom Berg

Graphics: Aaron Wilde and Pia Witt

ADVOCACY

RCI drives the message of renewable carbon and represents its stakeholders to the public and decision-makers.

SHAPING THE INITIATIVE

Members actively shape the direction of the initiative and the renewable carbon strategy.

VISIBILITY

Members are part of the RCI communication activities, are therefore highly visible and convey credibility. Get recognised as a pioneer in the transition to renewable carbon.

WORKING GROUPS

Members can form working groups on their desired topics such as technology and policy.

ACCESS

Members receive intimate information about RCI activities, strategies and budget allocations.

NETWORKING

Nobody can do it alone! Together with other RCI members you will create an eco-system for renewable carbon solutions – the renewable carbon community. All RCI members meet twice a year, once in person, once online.

JOINT RESEARCH

Members will be informed about upcoming research calls and the renewable carbon community will serve as a pool for project partners. Members can commission joint market and technology reports.

DISCOUNT ADVANTAGE

Members get discounts for selected partner events and selected studies.

BECOME A MEMBER OF THE RENEWABLE CARBON INITIATIVE AND SHAPE THE FUTURE OF THE CHEMICAL INDUSTRY

Join now!

renewable-carbon-initiative.com

Type of company

- LE – 10,000 €/year
- SME – 5,000 €/year
- Start-Ups – 2,000 €/year

RENEWABLE CARBON INITIATIVE