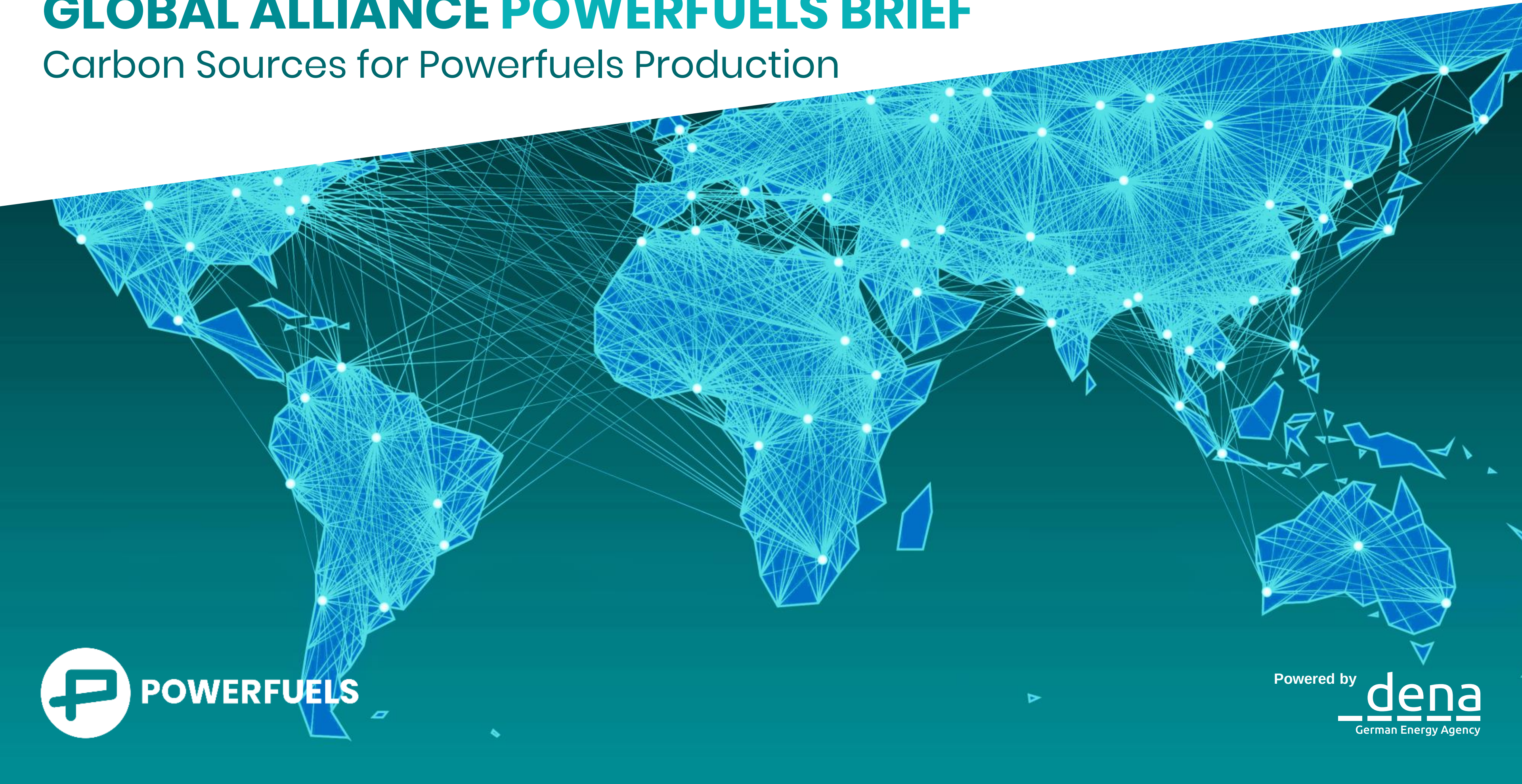
GLOBAL ALLIANCE POWERFUELS BRIEF

Carbon Sources for Powerfuels Production



POWERFUELS

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AGENDA

1 **Our work as the Global Alliance Powerfuels**

2 **Presentation of Alliance's discussion paper and analysis**

3 **Presentations by guest speakers Jekaterina Boening, Transport and Environment, and Stefan Gielis, CO2 Value Europe**

4 **Q & A and Discussion**

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Director,
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Johanna Friese
Expert,
Global Alliance Powerfuels

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Expert,
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Global Alliance Powerfuels – What we do

Advocacy & Communication

Raise awareness and acceptance of powerfuels as missing link to reaching global climate targets

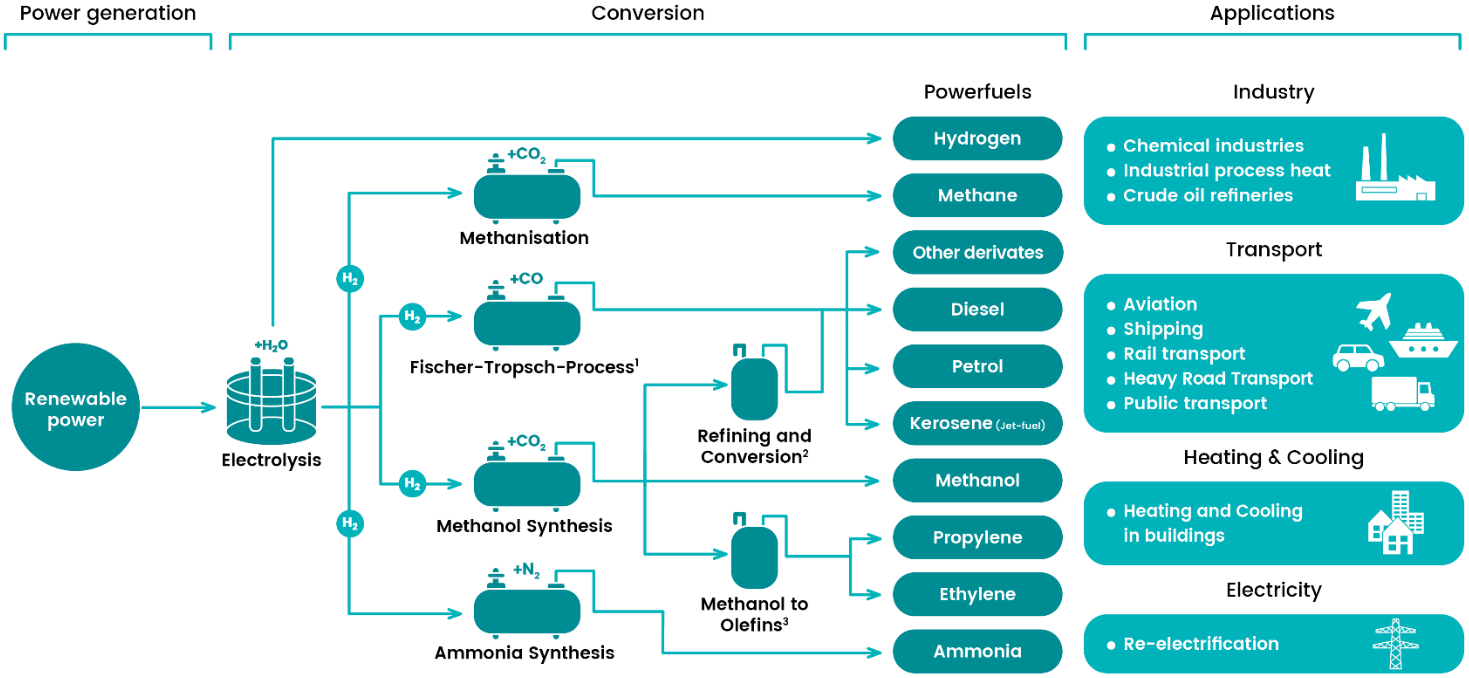
Policy & Regulation

Support the enhancement of regulatory frameworks with a focus on Europe as demand region

Global Project Development

Stimulate project development to globally enable production capacities

What are powerfuels?



1 Includes: Fischer-Tropsch synthesis, hydrocracking, isomerization and distillation.

2 Includes: DME/OME synthesis, olefin synthesis, oligomerisation and hydrotrating.

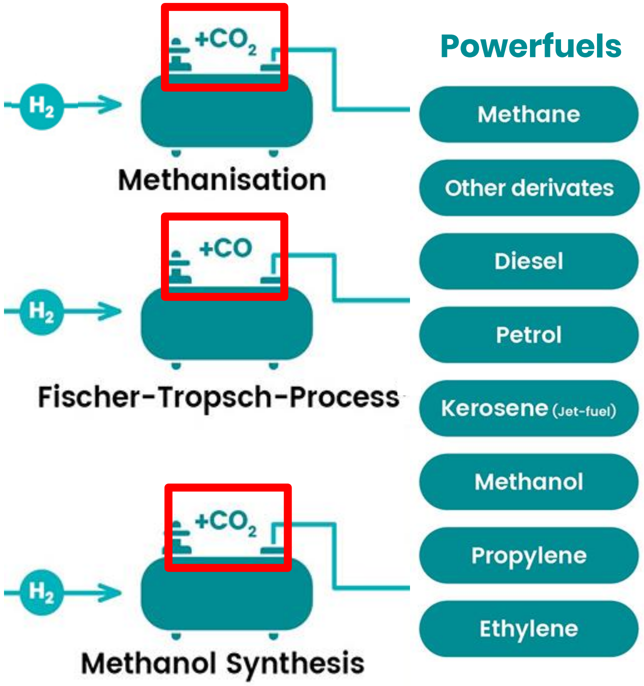
3 Methanol-to-olefins process.

Our global network

Our members

Our partners

CO_2 as a feedstock for powerfuels production



Requirement: CO_2 for powerfuels production should not cause additional net emissions

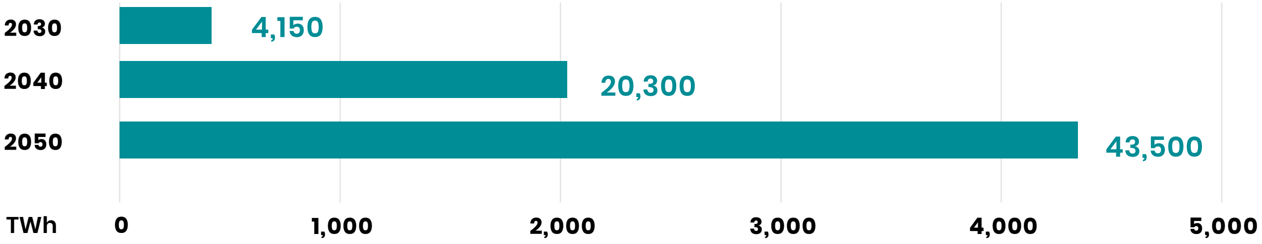
Task: Make technologies market ready to supply future CO_2 demand for powerfuels

Challenge: regulatory uncertainty regarding which carbon sources are eligible for powerfuels prodcution

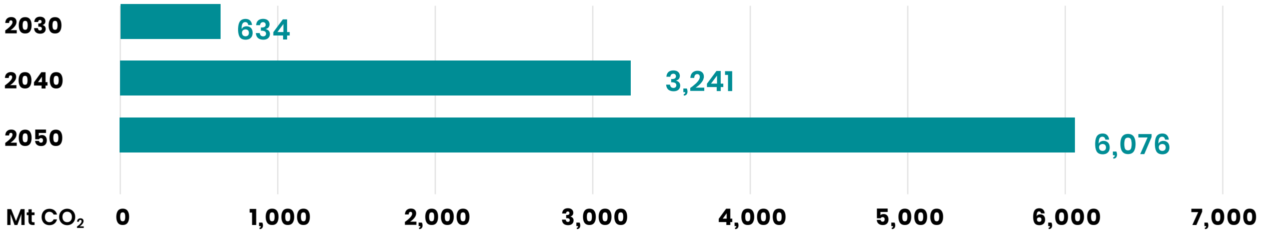
Significant carbon demand for future powerfuels production

- Demand for powerfuels will rise due to defossilisation
- CO_2 needed as a feedstock material for different powerfuels
- Demand for CO_2 will increase significantly
- Modelled 10-fold increase between 2030 and 2050

Global powerfuels demand



CO_2 demand for global powerfuels production



Source: LUT study „Powerfuels in a Renewable Energy World“.
Modell based on a global renewable energy system scenario by 2050.

Classification of potential carbon sources

1 Industrial CO_2 Point Sources

- Industrial emitters of CO_2
- E.g. fossil fuel power plants, industrial process plants
- Stationary
- Different capturing technologies, e.g. absorption, adsorption

2 Biogenic CO_2 Sources

- Biologically based CO_2 emitting processes
- E.g. biomethane production, biomass combustion
- Stationary
- Different capturing technologies, e.g. absorption, cryogenic separation

3 CO_2 from Ambient Air

- CO_2 from Direct Air Capture (DAC)
- Universal availability
- Technologies at early commercial stage

Classification of potential carbon sources

CO2 from combustion processes

- Coal
- Natural gas
- Fuel oil
- Biomass

CO2 as by-product of industrial processes

Biotechnological processes

- Biogas upgrading
- Bioethanol
- Fermentation

Chemical industry

- Ethylene
- Ammonia
- Refineries

Industrial production processes

- Cement
- Steel & Iron

CO2 from the atmosphere

- Ambient air

Biogenic carbon sources

Industrial point sources

Ambient carbon (through DAC)

Adapted from: Rodin et al., 'Assessing the Potential of Carbon Dioxide Valorisation in Europe with Focus on Biogenic CO2', *Journal of CO2 Utilization* 41 (2020)

Selection and Eligibility of Carbon Sources: Five criteria

COST

REGIONAL AVAILABILITY

VERIFIABILITY

SCALABILITY

SUSTAINABILITY
- GHG Intensity of Capture Process
- Unavoidability

Assessment of possible carbon sources: Cost

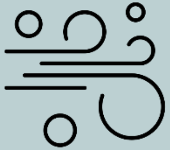
Costs of providing CO_2 vary greatly across **sources and technologies**

Influencing factors:
technology maturity, concentration and purity of CO_2, cost of energy provision for capture process

Industrial and biogenic CO_2 point sources

Cost range
50-100 €/ t

For **highly concentrated sources** costs **< 50€/t** (e.g. ammonia or bioethanol production)

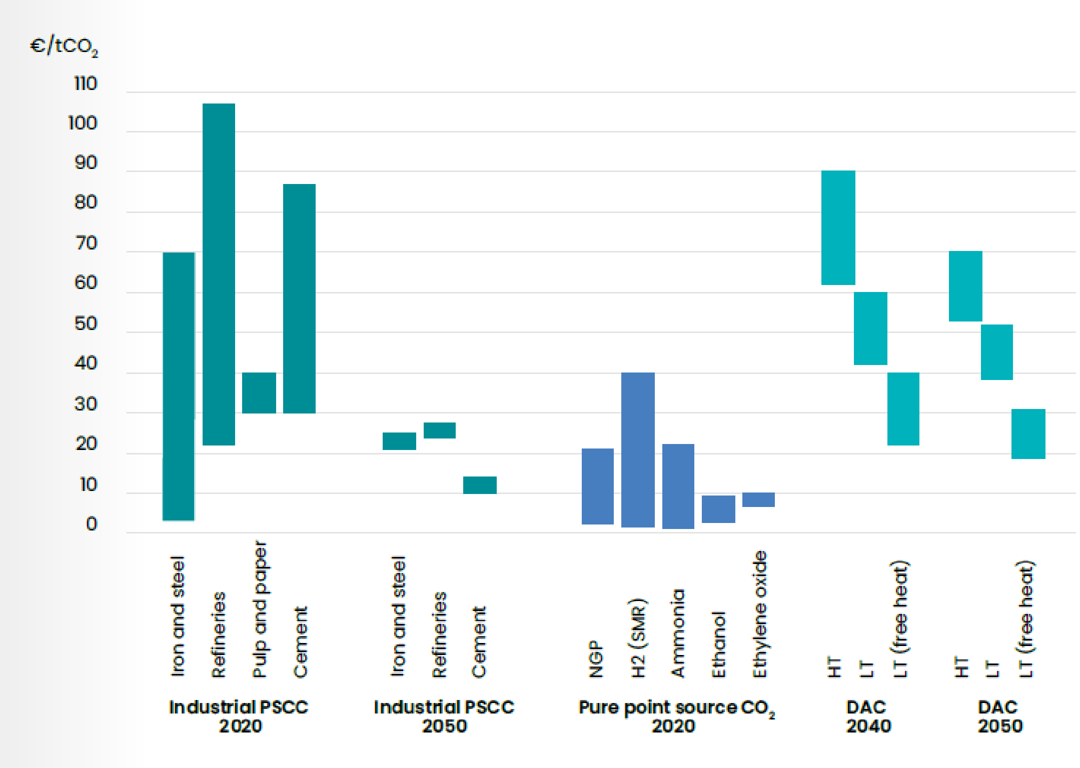


DAC

Cost range
300-600 €/t

Long-term cost projection
< **100 €/t**

Assessment of possible carbon sources: Cost



Projected range of carbon capture costs from point sources (PSCC) for different industries and DAC.

Adapted from: Mahdi Fasihi, Olga Efimova, and Christian Breyer, 'Techno-Economic Assessment of CO2 Direct Air Capture Plants', Journal of Cleaner Production 224 (1 July 2019).

Assessment of possible carbon sources: Scalability and expected long-term availability

Industrial CO_2 point sources

- Total useable CO_2 potential is expected to decrease sharply
- Long-run: CO_2 emissions from non-substitutable chemical reactions as only CO_2-emitting industrial processes
- Fundamental requirement: Providing CO_2 for powerfuels can neither increase nor prolong carbon emissions

Biogenic CO_2 sources

- Does not contribute to the net release of CO_2
- Competing uses for biogenic CO_2 as well as level of dilution and small size of many biogenic carbon-emitting sites limit attainable capture rates

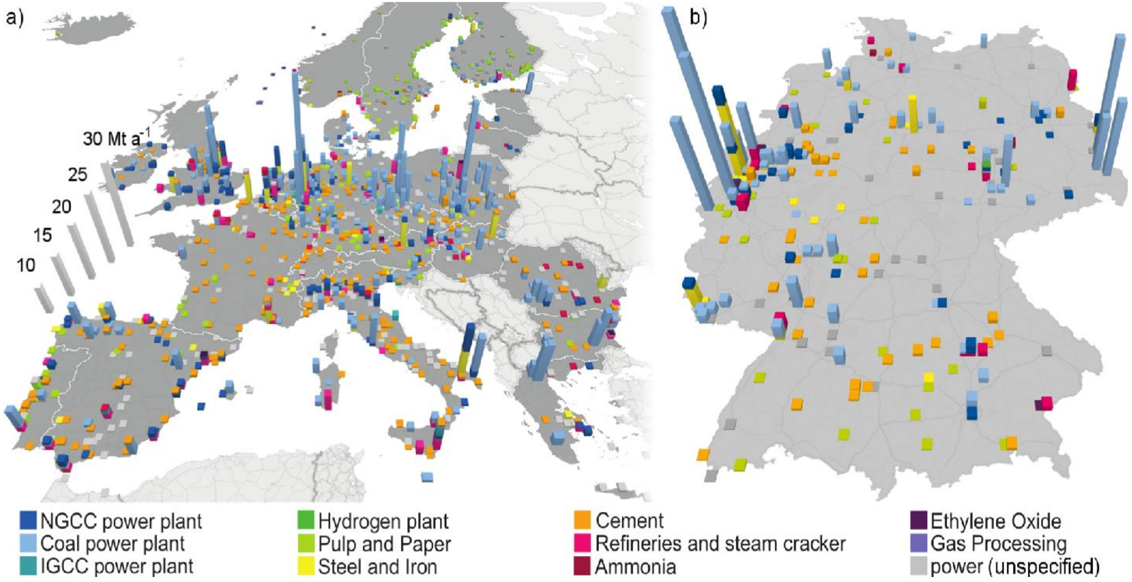
CO_2 from ambient air

- DAC technologies are considerably less limited in their scalability
- Independence from availability of industrial plants or related infrastructure
- Potential limiting factor: (renewable) energy demand for carbon capture

Assessment of possible carbon sources: Regional availability

Industrial point sources:

- Widespread and dispersed distribution, especially when looking at CO_2 sources classified as the most 'unavoidable' emitters
- Suggests decentralised installation of CO_2 utilisation technologies



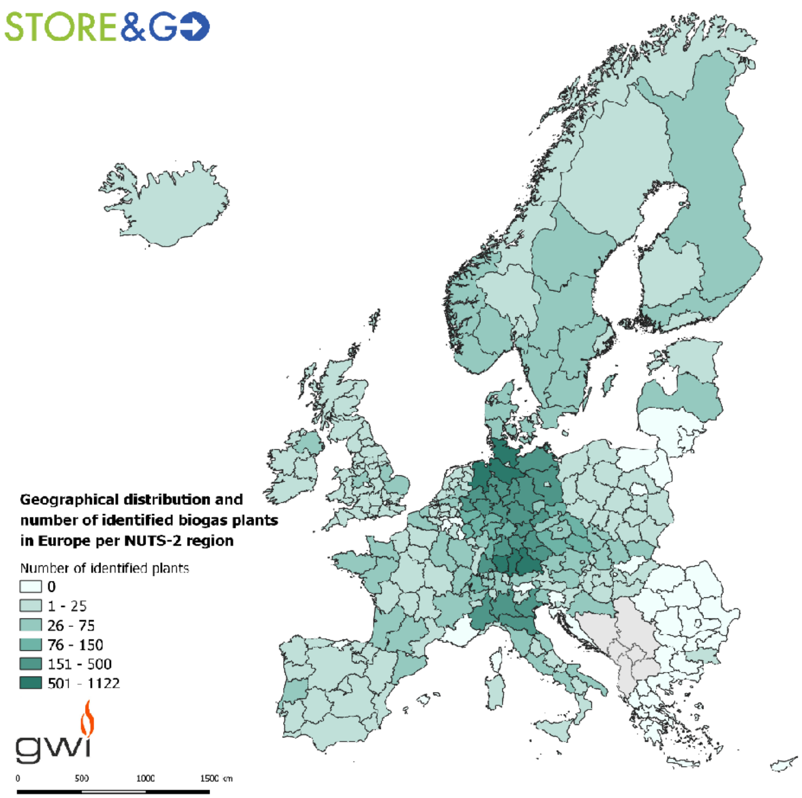
Distribution of industrial carbon point sources (>0.1 Mt a) in 2011 in a) Europe and b) Germany.

Retrieved from: Niklas von der Assen et al., 'Selecting CO2 Sources for CO2 Utilization by Environmental-Merit-Order Curves', Environmental Science & Technology 50, no. 3 (2016)

Assessment of possible carbon sources: Regional availability

Biogenic sources:

- Availability is highly clustered in some locations (e.g. Germany)
- European perspective: most countries engage in at least some level of biogas production
- Approximately half of these plants are within proximity of to renewable energy sources



Geographical distribution and number of biogas plants across European countries.

Retrieved from: Schaffert et al., 'Innovative Large-Scale Energy Storage Technologies and Power-to-Gas Concepts after Optimisation: Report on an EU-Wide Potential Analysis of Power-to-Gas Locations Coupled to Local CO2 and Renewable Energy Sources', 2020.

Assessment of possible carbon sources: GHG intensity of capture process

Industrial CO_2 point sources

- Location-dependent factors (e.g. source of electricity and heat supply)
- Industrial process-dependent factors (CO_2 concentration, purity)
- ‘CO_2 penalty’ higher for sources with lower CO_2 concentration, e.g. cement production (app. 0.4 t/t CO_2 provided)

Biogenic CO_2 sources

- Factors influencing the energy intensity of capture process similar to those for industrial point sources
- Biomass power plants: CO_2 penalty‘ higher for capture at pre-combustion than at post-combustion stage
- In biotechnological processes (e.g. biogas upgrading), CO_2 must already be separated

CO_2 from ambient air

- Considerably more energy-intensive than carbon capture from industrial point sources
- CO_2 penalty: estimates range around 0.5 t/t CO_2 provided; depends on specific DAC technology, selected energy sources

Assessment of possible carbon sources: Unavoidability

Meeting climate targets requires sharp reduction of contribution of industrial carbon sources to global GHG emissions. However, some products will still have to be manufactured via carbon-emitting industrial processes

Unavoidability principle is explicitly referenced in the RED II; however, no clear definition of 'unavoidable industrial carbon sources' exists as of date

Suggestion for guiding principle: possibility for substitution, both at the production stage and on the demand side

Assessment of possible carbon sources: Verifiability/creditability

+ **Market ramp-up of powerfuels** and recognition as **climate-friendly energy carriers** and feedstock requires renewable characteristics of input factors, including carbon sources, to be clearly defined and verifiable

+ **Industrial point sources:** CO2 captured and used in the production of powerfuels is eventually re-emitted
  - Emissions thus need to be accounted for
  - reductions can only be credited once to avoid ‘double-counting’
  - Non-additionality of captured carbon needs to be ensured

+ **Biogenic CO_2 sources and DAC**: Closed carbon cycle as CO_2 emitted at the use-stage of powerfuels is not additional

The current EU Policy Framework

- **CCU** is still a **novel idea**: CCU technologies is not sufficiently specified in EU terminology and definition of carbon sources for powerfuels does not exist
- **CCUS** is a **research priority** of the Energy Union and priority action in the Strategic Energy Technology Plan research agenda, but CCS is dominant
- The two most relevant directives to CCU are the ETS and the RED II
- There is, however, **egulatory uncertainty** regarding
  - climate mitigation potential of CCU in general and accounting of emissions
  - eligibility of carbon sources used in production of powerfuels
  - (sustainability)criteria
- There is **no investment framework** for deployment of DAC

This is problematic because it:

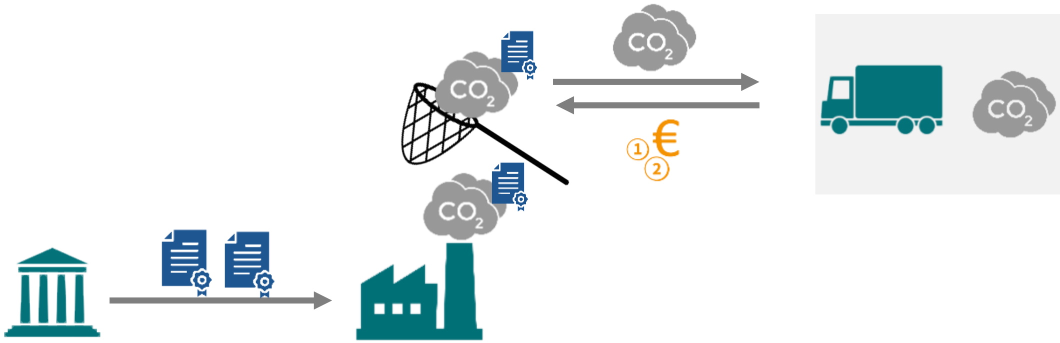
- inhibits market development of both powerfuels and CCU technologies, as planning and investment security are negatively affected by the uncertainty surrounding regulation.

The RED II

- **Use of electricity**: The electricity used during the carbon capture process could be required to comply with the sustainability criteria for electricity sources laid down in Article 27
- **Avoidability principle**: " 'recycled carbon fuels' means liquid and gaseous fuels that are produced from (…) or **from waste processing gas and exhaust gas** of non-renewable origin which are produced as an **unavoidable and unintentional** consequence of the production process in industrial installations"
  - No definition of "unavoidability"
- **Accounting of carbon**: upcoming Delegated Act of Article 28 of the RED II, due in December 2021, on methodology for assessing emissions savings from powerfuels and RCFs
  - Article 27: Powerfuels must provide at least a 70% reduction in GHG emissions compared to fossil counterparts

Possible emissions accounting mechanism : Carbon captured from industrial point sources and used in a non-ETS sector

- Allowing industrial sources covered by ETS only
- Limited by cap
- Must buy alowances

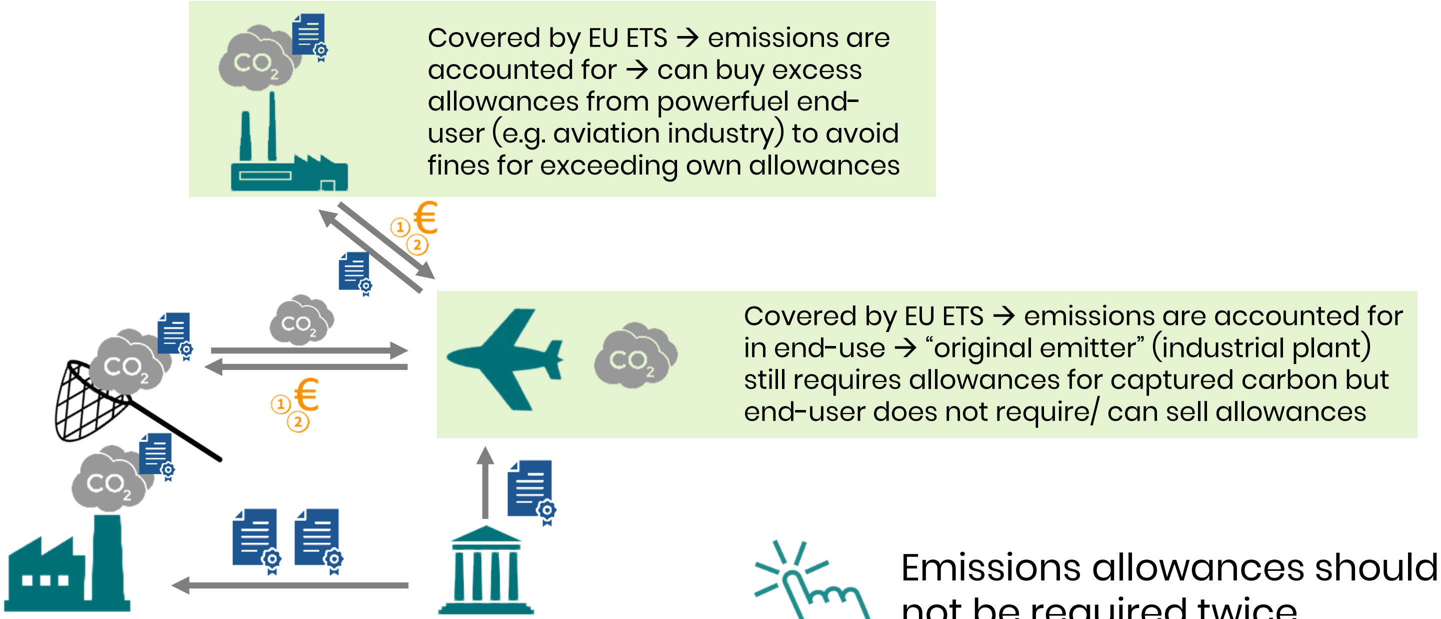


Not covered by EU ETS → emissions are not accounted for → “original emitter” (industrial plant) still requires allowances for captured carbon, but end user can credit emission reductions to sector-specific mitigation targets

Industrial plant covered by ETS, endowed with allowances to emit a specified amount of CO_2

Emissions allowances should not be bypassed

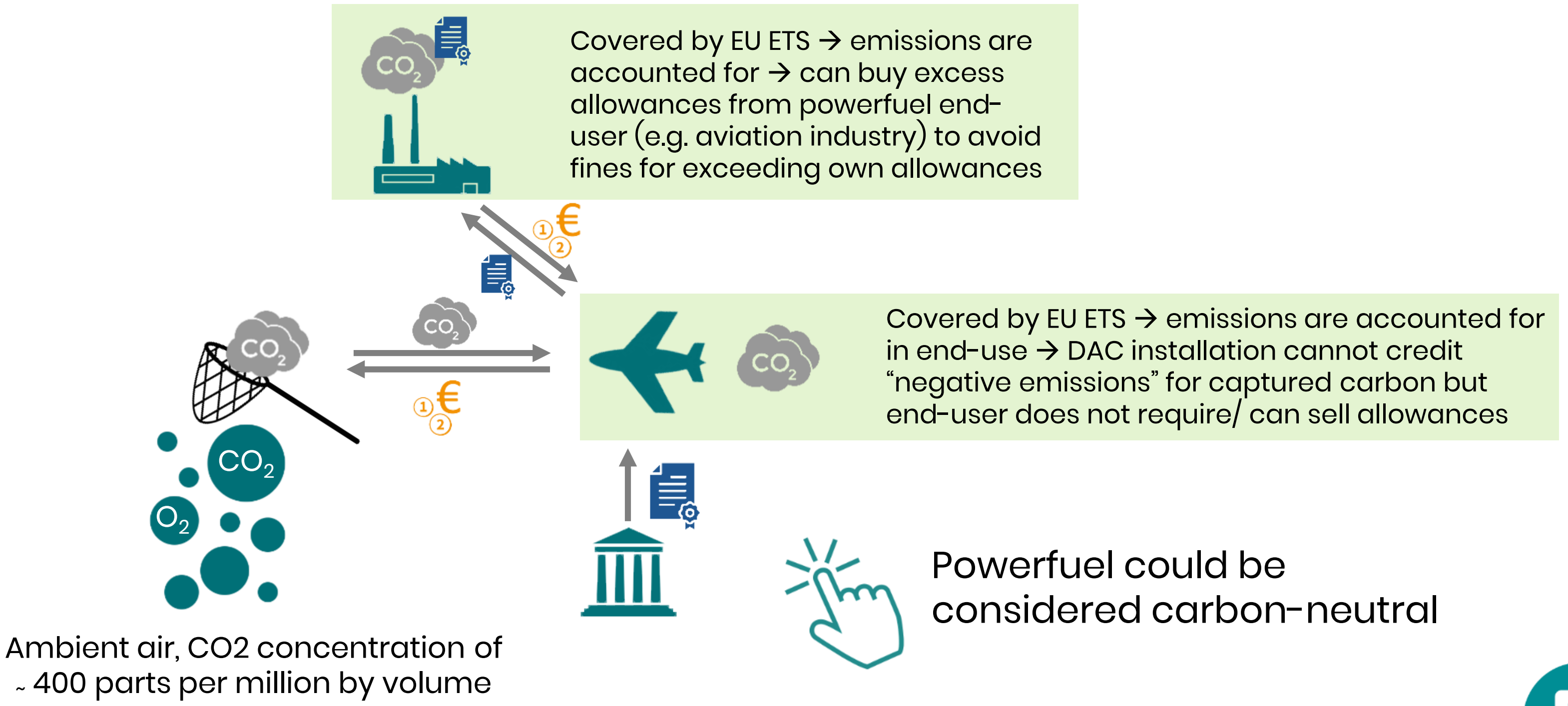
Possible emissions accounting mechanism : Carbon captured from industrial point sources and used in an ETS sector



Industrial plant covered by ETS, endowed with allowances to emit a specified amount of CO_2

Emissions allowances should not be required twice

Possible emissions accounting mechanism : Carbon captured from ambient air using DAC, and used in an ETS sector



Associated challenges

Outlined mechanisms would count emissions at the stage of capture and credit reductions at the end-use stage.

When developing an emissions crediting mechanism, the following challenges should be considered:

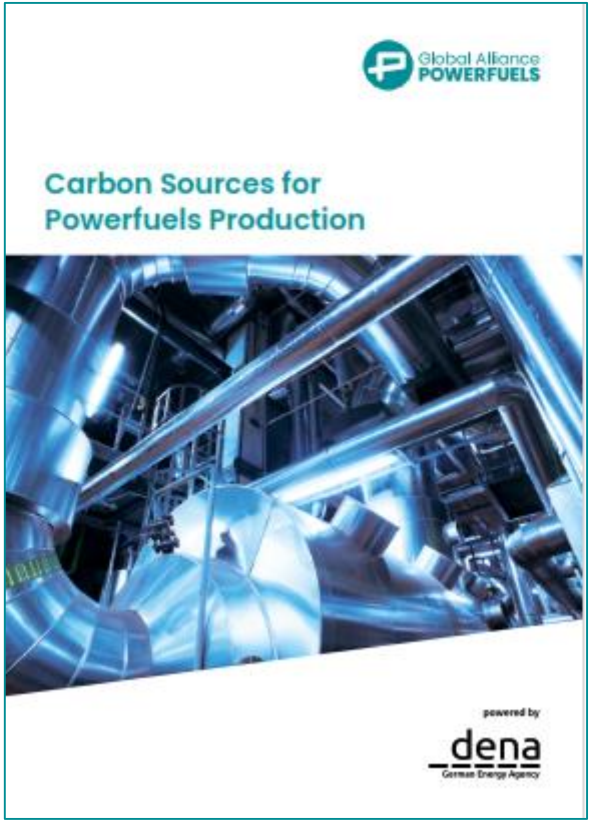
1. The EU **ETS and sector-specific regulations** for GHG mitigation, e.g. in transport, are based on **different approaches**.
2. Projections indicate that a significant share of carbon-based powerfuels will be produced in **regions outside the EU** and industry in these markets often **does not face emission caps** comparable to the ETS.
3. Fully counting emissions at the stage of capture, and crediting reductions at the end-use stage **would result in all powerfuels being treated equally at the usage stage** in terms of their GHG reduction potential.

General Policy Recommendations

1. A **clear definition** of CCU technologies should be provided.
2. **No additional net emissions**: No new carbon streams can be used and emission streams from existing industrial installations cannot be intensified.
3. **Multiple fulfilment options** should be allowed.
4. In the long-term, **biogenic carbon sources** and **DAC** should be **favoured**.
5. A well-designed and effective **policy support** should be put in place to induce **cost-degression of DAC** technologies.
6. The **international dimension** of powerfuels production outside EU needs to be accounted for.

Publication of Paper

- Will be published in the next days on powerfuels.org
- A PDF copy will be send to all attendees



Guest speaker

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TRANSPORT & ENVIRONMENT

Guest speaker

Stefan Gielis

EU Affairs Manager,
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Q & A and Discussion

Thank you for your attention

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