Climate-positive chemistry

Concepts, challenges and solutions - A study for Agora industry

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Project: Agora, Climate Positive Chemistry
Wissenschaft trifft Wirtschaft
15.09.2022 | Essen

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“Climate positive chemistry” – a study on the development of a mission statement for the chemical industry network

Current challenges

Study for a climate-neutral germany[1]*: Transition to a climate-neutral or climate-positive chemical industry is necessary.*

Multiple uncertainties exist:

- Political framework conditions are changing/ are unclear
- Approval procedures for new plants are lenghty
- Costs and Investments are typically relatively high
- The focus on specific technologies for the chemical industry leads to varying results and conclusions

Necessary investment costs and technology decisions are not clearly defined and remain vague

Solution approach

1. **Understanding** the complexity and challenges of the chemical industry and the relevant stakeholders.
   - Bilateral meetings - Workshop – Expert interviews-
2. **Development of facts** and calculation of carbon flows, investments costs, and raw material requirements as well as technology decisions for a climate-neutral or climate-positive chemical industry, including regional clusters.
3. **Highlighting** the need for renewable resources and the resulting political framework for long-term predictability.

Final output: Implementation study with regional solution approaches followed by publication and communication

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[1]Prognos, Öko-Institut, Wuppertal-Institut (2020): Klimaneutrales Deutschland. Study commissioned by Agora Energiewende, Agora Verkehrswende and Stiftung Klimaneutralität

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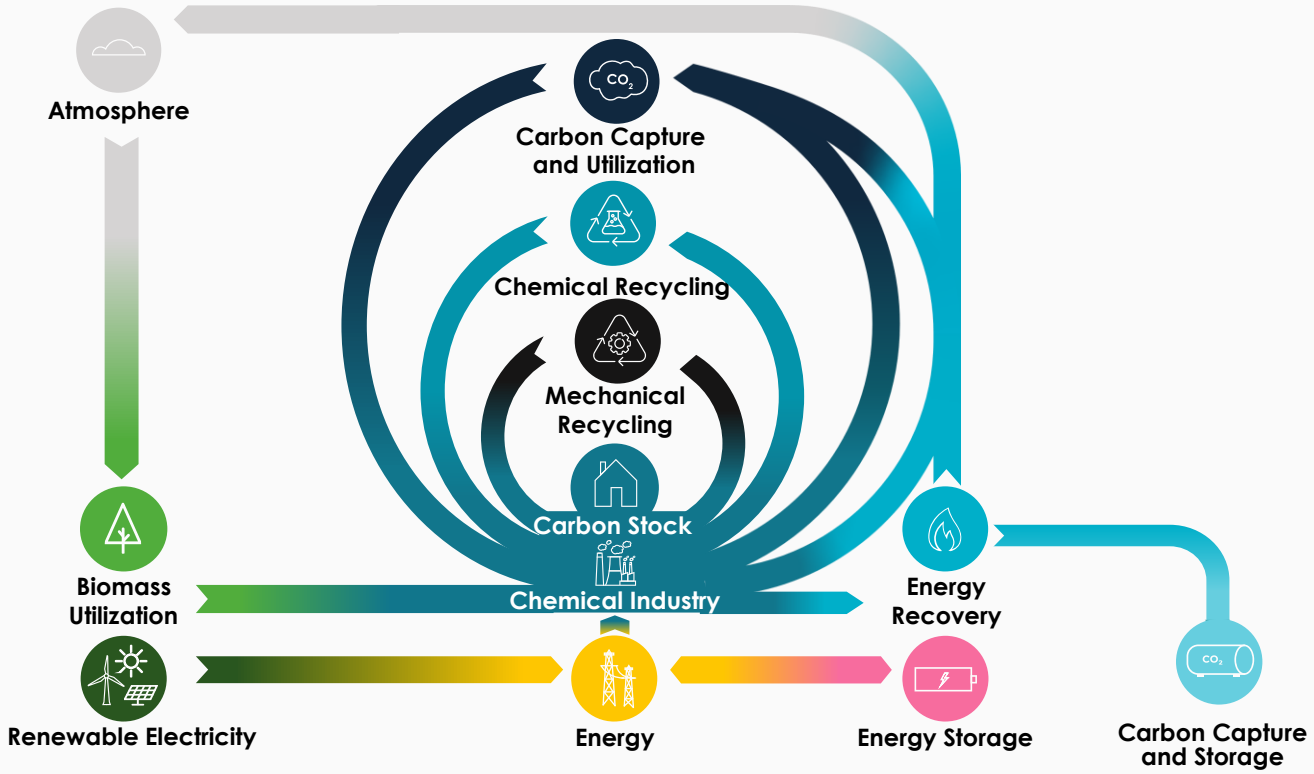
Chemistry as a driver for cross-sector carbon management: cornerstones for a climate-positive chemical value chain.

Carbon cycles managed by the chemical industry



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1. System-reinforcing & efficient electrification

- Electrification of process heat in synergy with renewable electricity (RE) and grid expansion
- RE-hydrogen in synergy with 2. & 3.

2. Resource-efficient recycling management

- Mechanical & chemical recycling
- Carbon storage in products
- Optimized primary raw material demand

3. Renewable carbon sources

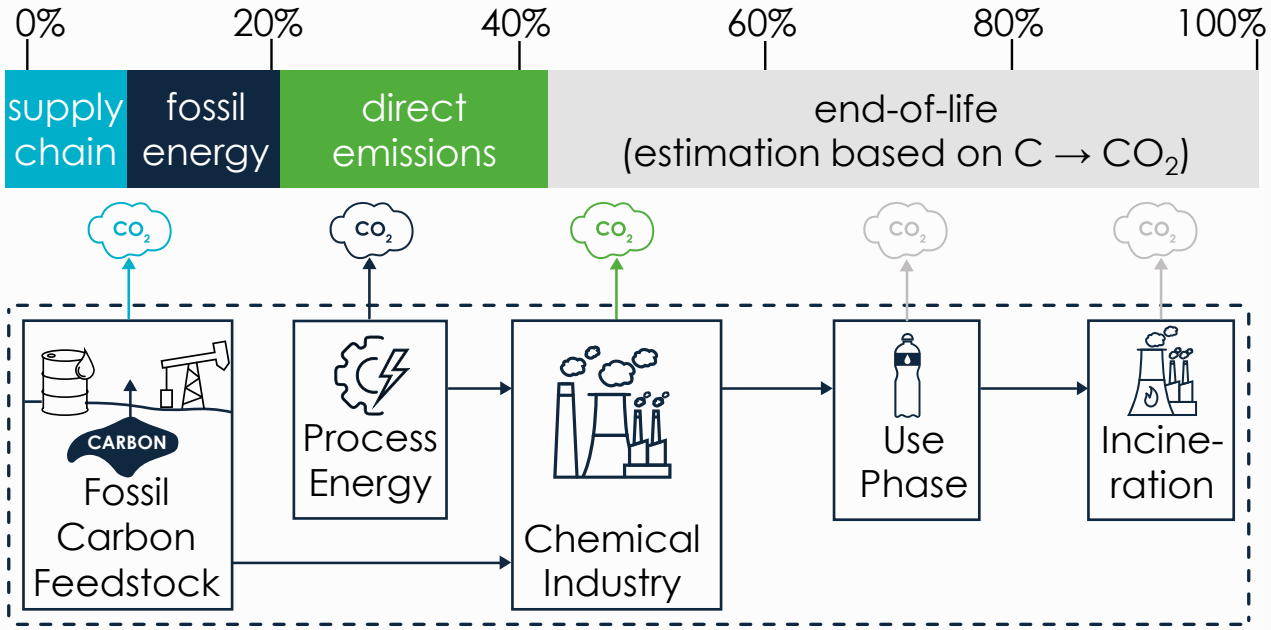
- Climate-smart forestry & agricultural management & use of biogenic CO_2 streams.
- Import of PtX products

Carbon storage through BECCS

- Integration with oxyfuel cement CCS
- H2 from partial oxidation with BECCS

Greenhouse gas emission of the German chemical industry and complex structure of the industry

Greenhouse gas emissions[1] over life-cycle stages in percent



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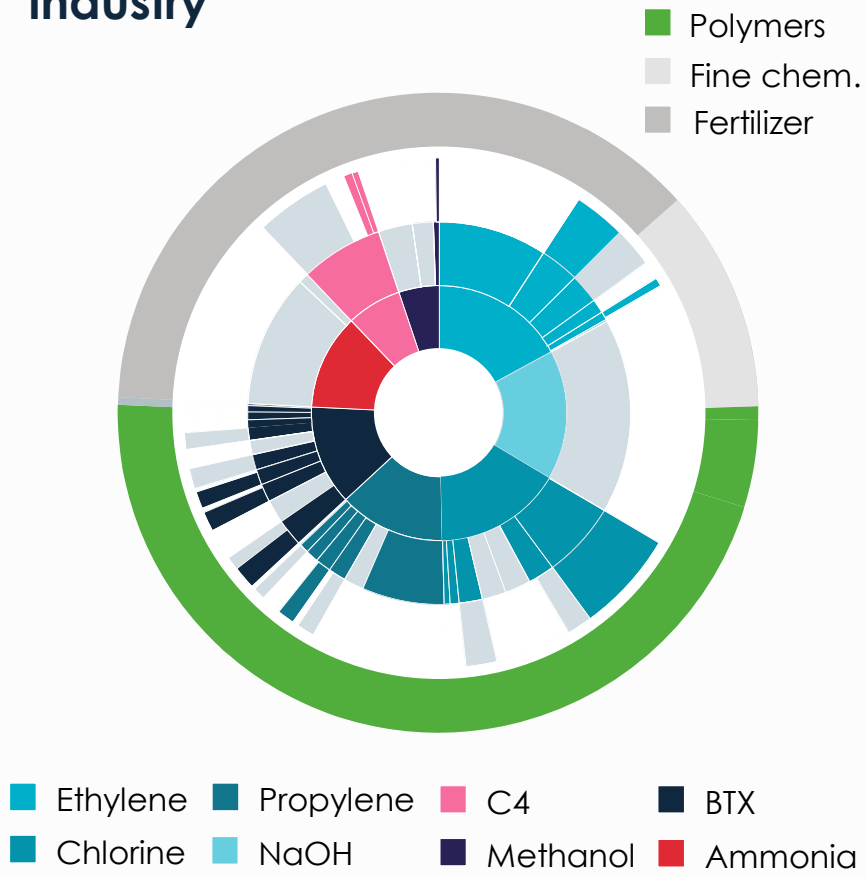
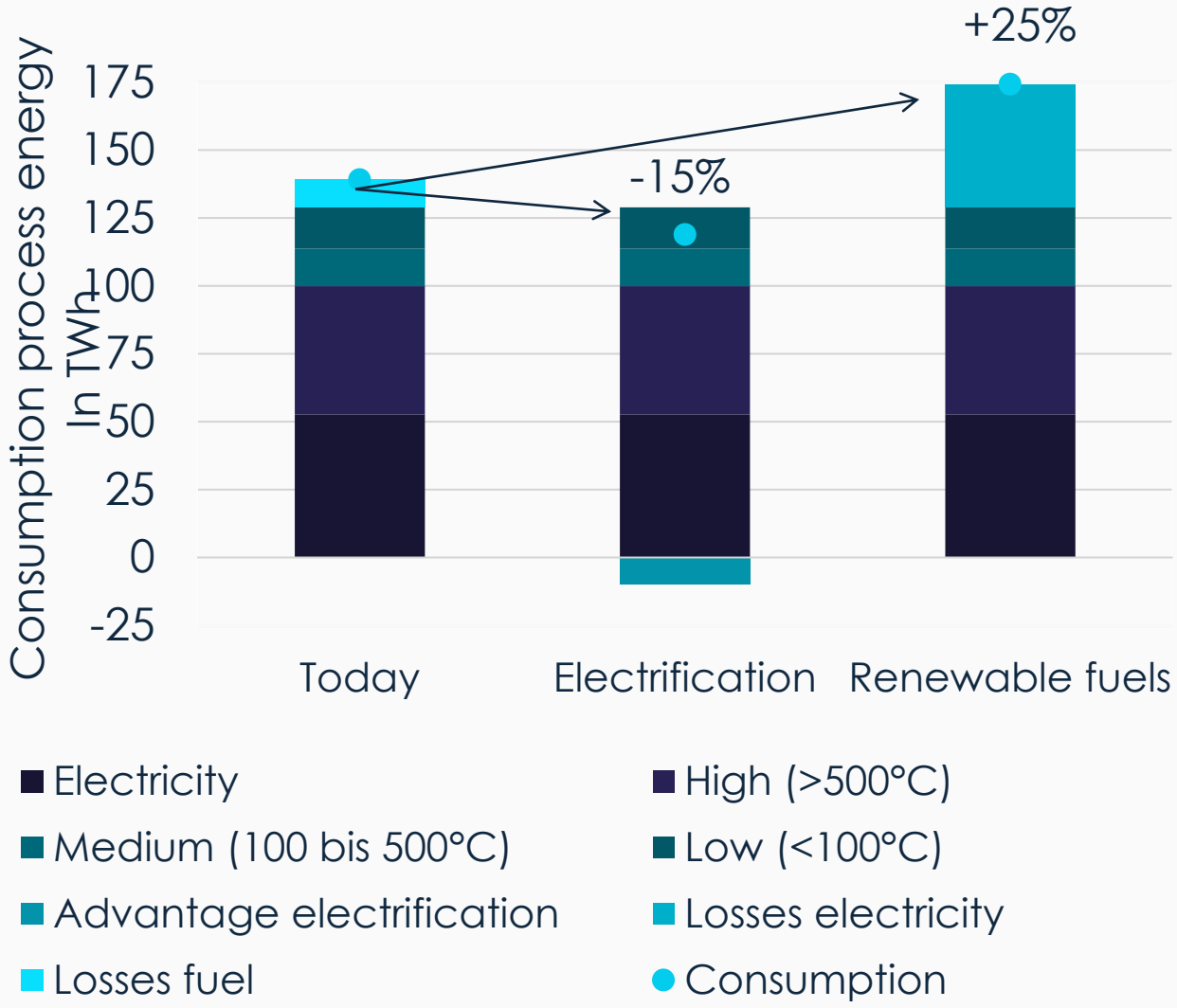
Structure of the German chemical industry



[1]Carbon Minds: Own modeling on the basis of the cm.chemicals database.

With electricity, almost everything can be done more efficiently than with fuels – you "just" have to choose the right technologies



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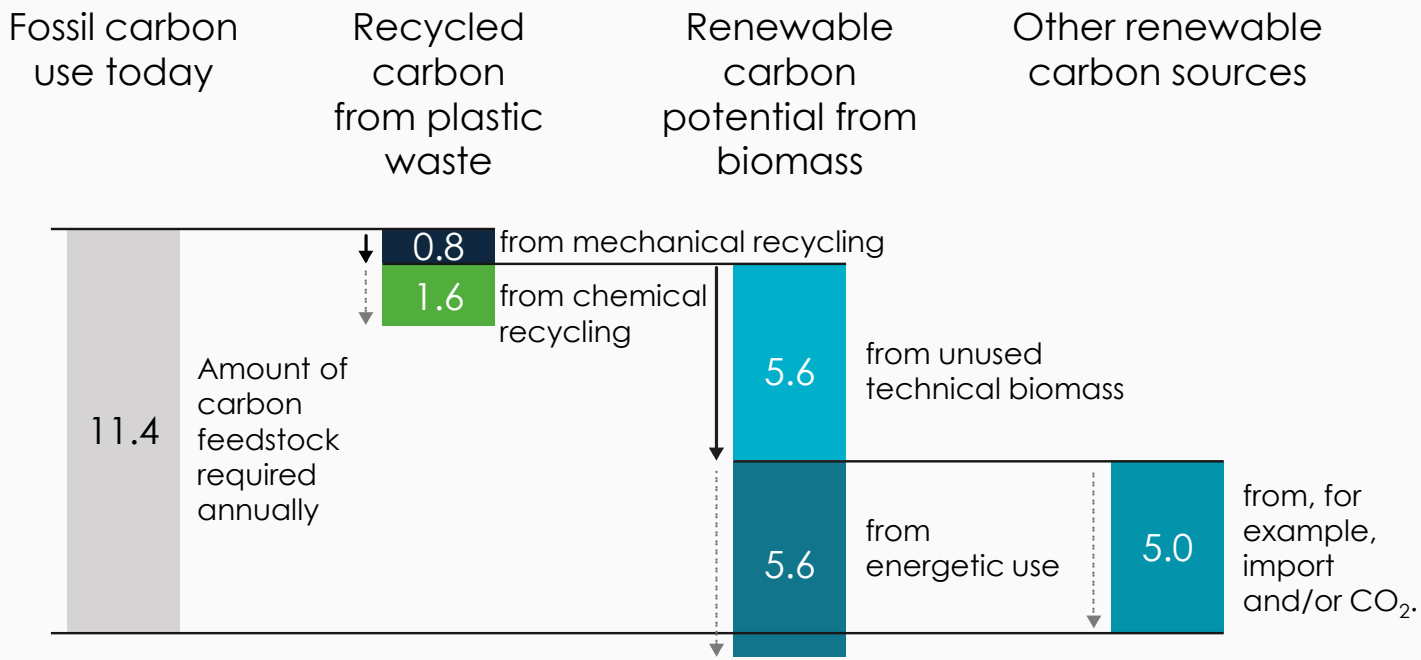
Efficient direct electrification with heat pumps and electric boilers can reduce the process energy demand of the chemical industry by 15%.

Using renewable fuels for process energy could increase process energy consumption by up to 25%.

Key message: A reliable power supply in combination with the use of efficient technologies can increase the long-term cost competitiveness of the chemical industry - Together, sufficient availability of renewable electricity at adequate prices must be ensured

The solution without remorse:
Recycling as a renewable carbon source

Alternative carbon source for the chemical industry (in megatons of carbon, estimate):



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Priority I: Optimization of the recycling rate

Resource-efficient material and chemical recycling. Potential import of end-of-life products to compensate for product exports.

Priority II: Use of biogenic C-sources

Material use of biogenic raw materials and promotion of climate-friendly forestry and agriculture by demand for residual materials.

Priority III: PtX with domestic C-sources

Additional carbon-rich feedstocks can be generated by H_2-assisted use of residues from recycling or biogenic nature.

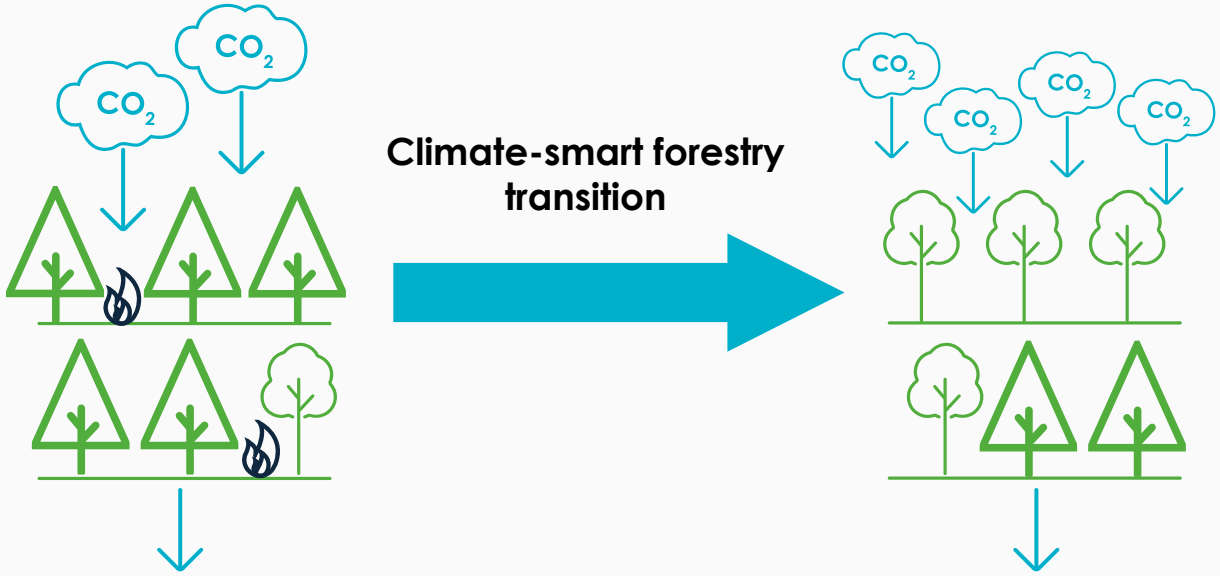
Priority IV: Import or CO_2 use

The remaining demand for renewable primary carbon feedstocks will be met through imports based on appropriate sustainability criteria.

Climate-smart forestry and a circular chemical economy is an opportunity to generate additional carbon sinks

Climate-smart forestry

Including long-term carbon storage



State-of-the-art
(Construction industry and energy production)

New utilization option
(Enhanced construction and chemical products)

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Climate-smart forestry aims at increasing forests' resilience and adaptive capacity to maintain climate protection functions and ecosystem services in the long term (Verkerk et al., 2020).

Climate-smart forestry is based on three pillars:

1. Optimize carbon storage in forests and wood products without neglecting ecosystem services;
2. Increase resilience and vitality of forests through adaptive management practices;
3. Optimize the sustainable use of wood to replace fossil resources.

The forest and chemical sector combined (1) ensure a more stable forest that can sequester more carbon dioxide in the long term, and (2) promote the usage of renewable carbon.

Thank you!

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