Carbon2Chem®

CO_2-Sources and Infrastructure
Changes along Transformation Pathways

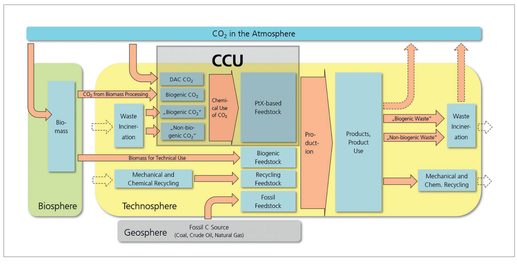
Involved Partners: thyssenkrupp Steel Europe AG | Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT | Lhoist Germany Rheinkalk GmbH | Thyssen Vermögensverwaltung GmbH | thyssenkrupp nucera AG & Co. KGaA | thyssenkrupp Uhde GmbH
Associated partners: Remondis Energy and Services GmbH & Co. KG | GMVA Niederrhein GmbH

Objective

CO_2 formation will change along transformation pathways: Whereas power generation can be decarbonised by use of renewable energy, transformation in the industry sector is more complex. Some CO_2 formation can be avoided by switching to more sustainable production routes, but other processes are inseparably associated with CO_2 formation. Residual amounts of CO_2 with a timescale up to 2045 and their suitability for CCU processes, both from a technical and regulatory point of view, have been assessed in this project.

Strategy

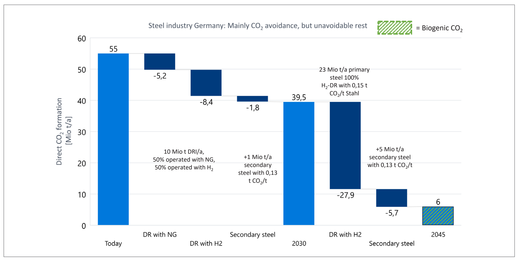
Today's linear use of fossil carbon for energetic and material use has to be replaced by decarbonized energy and by circular use of carbon for materials in order to reach climate neutrality. All unavoidable CO_2 emissions have to be compensated by carbon sinks in a climate neutral system.
In detail, this is complex and requires new CCU value chains, with a growing share of biogenic and perspectively athmospheric carbon.



Carbon recycling paths within the technosphere and potential role of CCU.

Transformation paths and CO_2 formation in steel industry and lime industry

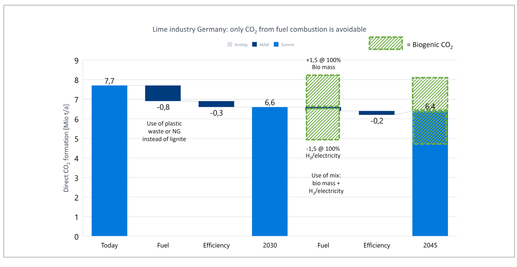
In steel industry, the majority of CO_2 can be avoided by replacing the blast furnace route with a combination of H_2-based direct reduction and an increased scrap share. About 5-10 % of CO_2 formation will be unavoidable for metallurgic reasons, but this could come from biogenic carbon in future.
In lime industry, ⅔ of the total CO_2 formation is related to limestone decomposition and unavoidable. Fossil fuel (⅓ of CO_2 now) can be substituted by biogenic sources, increasing both total amounts and biogenic share, or CO_2 formation can be decreased by electrification and use of H_2.



CO_2 formation in steel industry along transformation paths (assumption: constant total production volumes in Germany over time).

CO_2 origin in waste incineration and conclusion

In waste incineration, CO_2 formation is expected to stay in its current range, with an increase of the share of biogenic CO_2 from 50-60 % today to about 70 % in future. In total, the discussed industries will have residual CO_2 formation even after complete transformation in the Mio t/a scale, with varying share of biogenic carbon, which makes them suitable sources for CCU.



CO_2 formation in lime industry along transformation paths (assumption: constant total production volumes in Germany over time).

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A KEY BUILDING BLOCK FOR THE CLIMATE PROTECTION

CO_2 reduction by cooperation of process industrial sectors