



Area 3, Topic 3.1

Closing the Carbon Cycle in Industry

Industrial feasibility of catalytic routes for sustainable alternatives to fossil resources

*Soren Bowadt
Deputy Head of Unit
“Materials For Tomorrow”
DG Research and Innovation*

Closing the Carbon Cycle in Industry

Demonstrate the Industrial feasibility of catalytic routes for sustainable alternatives to fossil resources.

- ✓ In line with the European Green Deal of President von der Leyen, this proposal aims to contribute towards achieving the climate and environmental related challenges to reach the 55% GHG reduction targets by 2030 and full climate neutrality by 2050 as well as circularity objectives.
- ✓ This requires the full mobilization of European Industry, especially the energy intensive industry.

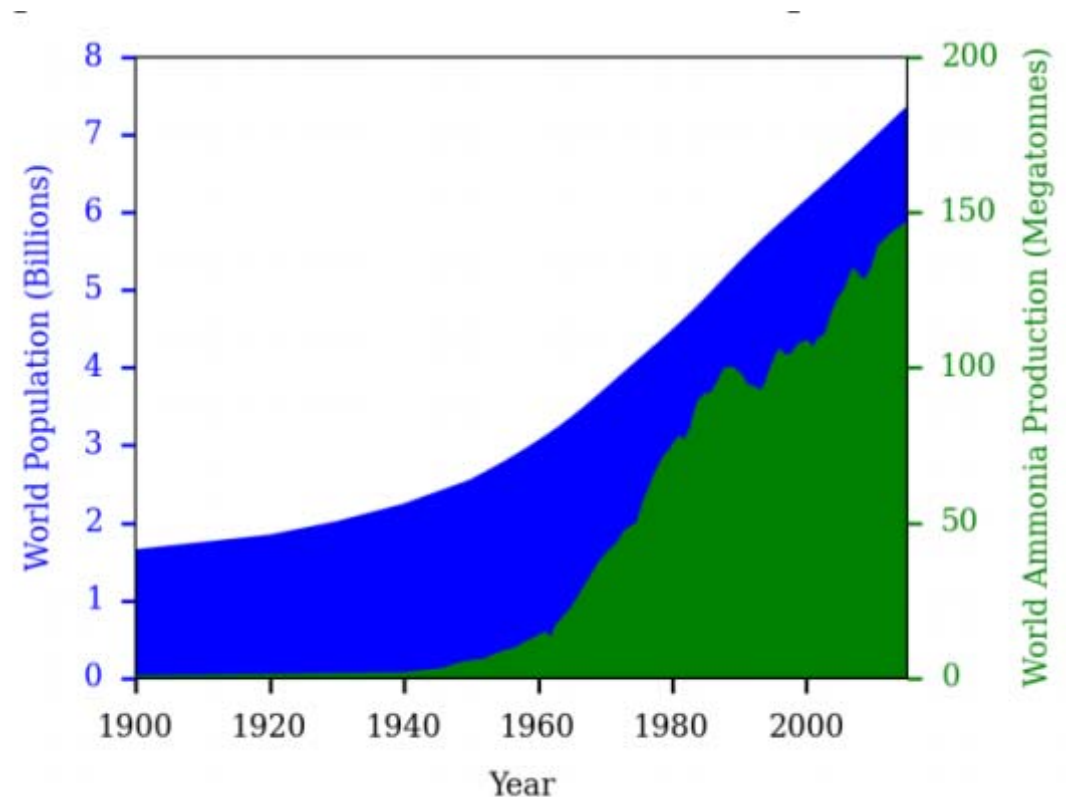
- ✓ The process industries in Europe are the largest single point sources of GHG in Europe accounting for ~20% of GHG.
- ✓ This industry is heavily dependent on fossil resources to produce the both the basic materials and value added products needed for our modern society, and cannot easily change their full production systems.
- ✓ Viable solutions to the problem are therefore needed without risking millions of European jobs depending on the process industry and at the same time create new job opportunities.

- ✓ We are looking towards new catalytic systems in conjunction with renewable energy (solar, wind and hydropower), to facilitate the transformation of CO₂ into feedstock, fuel and chemicals, thereby replacing fossil resources.
- ✓ How can catalysis help?
 - i. By increasing the energy efficiency of the transformation
 - ii. Re-use large industrial point sources of CO₂
 - iii. Reduce imports of fossil resources and help circularity
 - iv. Improve flexibility in storage of high density energy (fuels)
- ✓ How can a technology like Catalysis actually help society?

Historic Example: Ammonia synthesis

A catalytic reaction with a major societal impact

- Population growth in the last century is inextricably linked with the development of ammonia synthesis (Haber-Bosch process), since the possibility to produce enough food for all is strictly correlated with availability of fertilizers, of which ammonia is a key component.
- Ammonia production causes 1.5% of total global GHG emissions. On average, about 2-3 tons CO₂ are produced per ton ammonia. *New routes for "green ammonia" could cut up to 90% these GHG emissions*
- Key to lowering CO₂ burden of ammonia synthesis is realising green hydrogen



✓ In concrete terms what impact do we want to achieve:

- i. Demonstrate the technology in near industrial scale, which means transforming > 4000 tons CO₂ into feedstock, fuels and chemicals.
- ii. Include all aspects of the related industrial value chain (and support Europe's position as a global leader).
- iii. Use primarily current industrial infrastructure, whereby limiting Capital Expenditure.
- iv. The processes should be based on detailed Techno-economic and Lifecycle Assessment considerations.
- v. Arrive at TRL 7 within 5 years from the start of the project.
- vi. Lead to full industrial scale projects by financial means outside the European Framework program for R&I (e.g. EU-Invest, MS, Industry).

✓ Further impacts:

- i. Should demonstrate the potential for a reduction of industrial CO₂ emissions of ~ 200 Mt p.a. by 2050.
- ii. Affordable and highly efficient production, storage and distribution of renewable energy carriers (including fuels and H₂).
- iii. Indirect improvement of the air quality and health effects through the filtering of the flue gas emissions from large point sources.
- iv. Address financial, regulatory and associated environmental aspects and thereby contribute to industrial circularity through preferably direct transformation of CO₂ from industrial emissions.
- v. Foster cross-sectorial European Innovation eco-system to deploy sustainable alternatives to fossil resources.
- vi. Societal engagement, transparency, training and new skills of employees, researchers etc.

✓ What is not foreseen in the topic proposal:

- i. Small projects that do not deliver a quasi-full-scale demonstration of the potential of industrial CO₂ use from large point sources.
- ii. While Direct Air Capture seems attractive and is not excluded, it is unlikely that this could be implemented already as it is estimated that the concentration of CO₂ alone will lower the efficiency of the overall process by 5-10 %.
- iii. The same goes for Bio-technological solutions, because the scale foreseen in the industrial demonstration and the direct conversion of flue gasses without pre-treatment likely prevents its integration.

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A Circular Economy of Carbon

