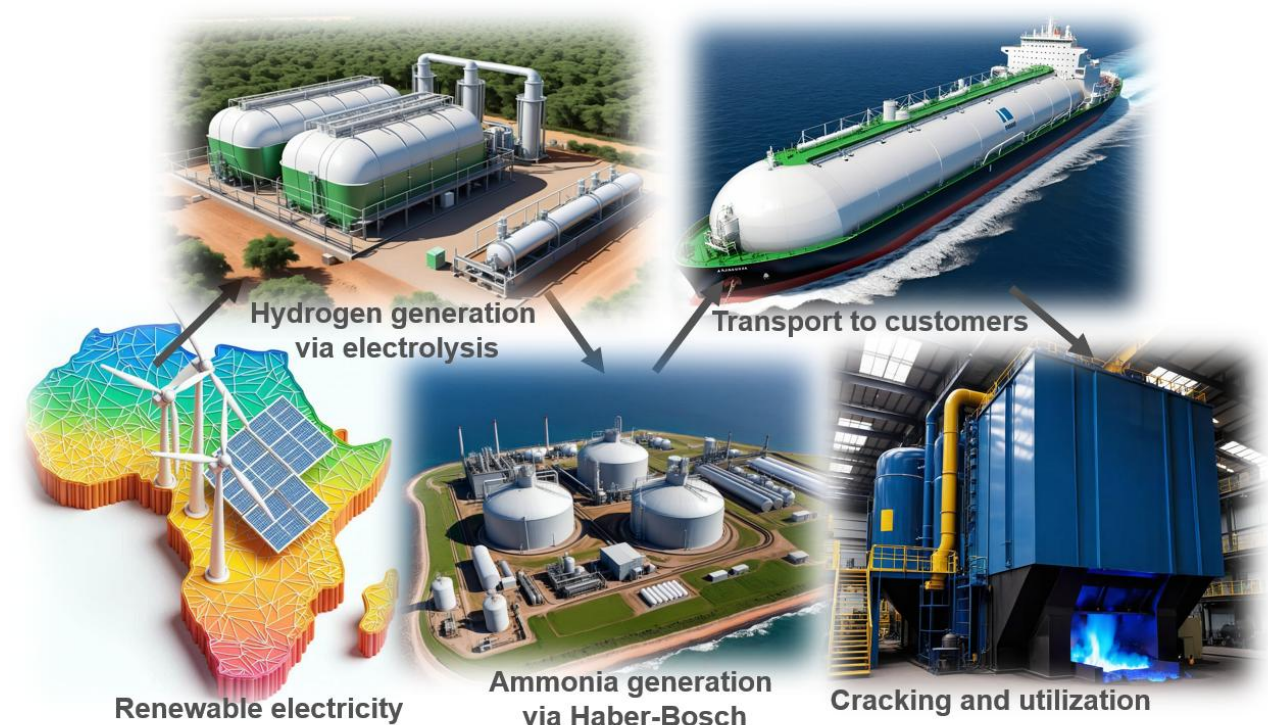


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Ammonia Cracking as a Key Enabler for Resilient and Carbon-Free Energy Supply Chains in Industrial High-Temperature Processes

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Energy supply chain of imported green ammonia for industrial furnaces

Despite the ongoing expansion of domestic renewable energy capacities, Germany and Europe will remain dependent on imports of physical energy carriers, particularly for hard-to-electrify industrial sectors. While current supply chains are dominated by fossil carbon carriers such as crude oil and its derivatives, the transition towards renewable systems requires carbon-neutral and carbon-free alternatives. Among these, ammonia is a promising hydrogen carrier due to its favorable storage and transport properties compared to compressed or liquefied hydrogen.

Future infrastructures are expected to rely on centralized import hubs, where ammonia is either cracked into hydrogen and fed into hydrogen networks or distributed in liquid form to decentralized industrial users. While ammonia can in principle be directly used as a fuel for industrial furnaces, its low laminar flame speed and the tendency for elevated NO_x emissions pose significant challenges for stable and clean combustion. In addition, direct combustion is energetically disadvantageous, as the enthalpy required for ammonia evaporation and cracking is drawn from the useful heat of the process rather than being supplied by otherwise unused waste heat streams. However, efficient and application-oriented ammonia conversion remains a key challenge. Decentralized cracking concepts for thermoprocess industries are constrained by the limited availability of process waste heat at temperature levels typically between 300 and 600 °C, which is significantly below conventional ammonia cracking conditions.

The project addresses this challenge by combining system-level assessment with experimental investigation. The objective is to evaluate the feasibility of different ammonia supply pathways and to identify suitable catalysts and operating windows for decentralized cracking. A life cycle assessment (LCA) is conducted to compare centralized cracking with hydrogen distribution and decentralized cracking at the point of use.

Experimentally, the project focuses on catalytic ammonia cracking under industrially relevant conditions, with particular emphasis on low-temperature operation and the utilization of available waste heat downstream of recuperation systems. Investigations include ammonia conversion, temperature-dependent performance, and operational stability.

The expected results provide insights into the technical feasibility and system-level implications of integrating ammonia cracking into thermoprocess industries. By linking experimental data with LCA results, the project aims to identify viable pathways for using ammonia as a carbon-free energy carrier under realistic industrial boundary conditions.