How to overcome challenges in Green Ammonia through a multisciplinary research in catalysis

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Nowadays, most of the ammonia produced worldwide derives from fossil-based hydrogen. As a result, the Haber-Bosch process represents the biggest emitter of carbon dioxide among all industrial chemical syntheses [1]. In light of The Paris Agreement, emission regulations will become progressively stricter over the following decades, thus making necessary the device of sustainable manufacturing pathways to meet the decarbonization targets. As a result, chemical companies are already developing greener processes to comply with the new policies and decarbonize their activities. For this reason, the research of sustainable production of ammonia, replacing fossil fuels with green or zero-carbon, is fundamental for academia, industries and governments. Green ammonia (gNH3) production involves the use of green hydrogen in the Haber-Bosh process using renewable electricity [2]. Therefore, due to the nature of the renewable energy sources, it is crucial to precise characterize the converter functioning when undergoes fluctuations under operating conditions [3]. Moreover, also the behavior of ammonia synthesis catalyst must be verified, since its behavior at non-stationary conditions, is a missing information and no experimental evidences are currently available in the scientific literature.

The goal of the work is to present the challenges of the process and how to overcome these challenges through different strategies that involve catalyst studies, modelling of the process and utilization of optimizers to calculate the levelized cost of ammonia ($LCOgNH_3$) taking into account the available renewable energy during the year.

[1] The Royal Society. Ammonia: Zero-Carbon Fertiliser, Fuel and Energy Store. Policy Briefing, The Royal Society, London. **2020**.
[2] *Sust. Energy Fuels*, 5, 2814, **2021**.
[3] M. Ravi, and J.M. Makepeace, *Chem. Sci.*, 890, 13, **2022**.