



Environmental Catalysis in Industry: The Road Ahead

Pierdomenico BIASI^{*1}, Raffaele OSTUNI¹, Alberto GARBUJO¹, Filippo BUTTIGNOL¹, Ludovica VILLANTIERI¹,
Michal BIALKOWSKI¹,

¹CASALE SA, R&D Division, Via Giulio Pocobelli 6, 6900, Lugano, Switzerland.

^{*}*p.biasi@casale.ch*

The green chemicals market is a growing segment of the broader chemical industry, with a global market value exceeding \$100 billion in 2022 and projected to reach over \$270 billion by 2032¹. Environmental catalysis is increasingly recognized as a strategic enabler for industrial decarbonization and green chemical market, offering practical solutions to reduce emissions, improve energy efficiency, and meet evolving environmental regulations. From an industrial perspective, the adoption of catalytic technologies is not only a matter of environmental compliance but also a driver of operational competitiveness and long-term sustainability.

However, the shift toward renewable energy sources, characterized by their intermittent and variable output, introduces new operational challenges. Catalytic abatement systems, traditionally optimized for steady-state conditions, must now adapt to fluctuating loads, variable feedstock quality, and dynamic process conditions. This necessitates a rethinking of plant design, control strategies, and catalyst durability to ensure consistent performance and economic feasibility under non-continuous energy supply scenarios. Special attention is given also to the industrial deployment of green ammonia and green methanol technologies, which are reshaping the production landscape. Companies like Casale SA are leading the transition by integrating advanced catalytic systems into modular, scalable plant designs that accommodate renewable energy inputs. These solutions enable the production of green chemicals and/or energy carriers using hydrogen from electrolysis and captured CO₂, aligning with global decarbonization goals while maintaining industrial viability²⁻⁴.

Chemical industry needs to actively respond to the challenges posed by the transition to low-carbon and renewable energy systems. Industrial players are increasingly adopting flexible process integration strategies that allow for dynamic operation under variable energy inputs, particularly from intermittent renewable sources like solar and wind. Advanced control systems and digital process monitoring are being implemented to maintain stability and efficiency in catalytic processes despite fluctuating conditions.

Moreover, the integration of hybrid energy-storage solutions—such as batteries, thermal storage, and hydrogen buffers—enables plants to decouple energy supply from demand, ensuring continuous operation of catalytic units. The industry is also innovating in the application of catalytic materials, not only through the design of new catalysts tailored for dynamic environments but also by repurposing traditional catalysts in novel configurations or under modified operating conditions to enhance resilience and performance.

Beyond technological adaptation, the chemical industry increasingly recognizes the pivotal influence of national and regional policies, as well as geopolitical and energy resource shifts, in shaping the pace and direction of catalytic technology adoption. The ongoing energy transition is prompting industries to reassess their strategies in light of evolving energy availability, infrastructure, and regulatory landscapes⁵. Policy instruments—including subsidies for green hydrogen, carbon pricing schemes, and stringent emissions regulations—are proving essential in steering industrial investment toward cleaner technologies. At the same time, growing market demand for low-carbon products, such as green ammonia and green methanol, is opening up new economic opportunities and reinforcing the strategic value of catalytic innovation as a core component of sustainable industrial development.



Ultimately, environmental catalysis is positioned not merely as a scientific advancement but as a strategic pillar of industrial transformation, enabling the chemical sector to align with global climate goals while maintaining competitiveness in a rapidly evolving energy landscape⁶.

In conclusion, as the chemical industry navigates the complexities of the energy transition, environmental catalysis stands out as a critical enabler of both technological innovation and strategic resilience. Its integration into industrial systems not only supports the shift toward renewable energy and low-carbon production but also reinforces the sector's ability to remain competitive, adaptive, and aligned with global sustainability objectives. The convergence of market demand, policy support, and industrial innovation positions environmental catalysis as a cornerstone of the next generation of green chemical manufacturing.

References

1. <https://www.gminsights.com/industry-analysis/green-ammonia-market>
2. www.casale.ch
3. E. Filippi and C. Pizzolitto, *Catalysis Today* **2022**, 387, 9-11
4. J. Rostroup-Nielsen, *Catalysis Today* **2023**, 423, 113878
5. <https://www.coherentmarketinsights.com/industry-reports/green-ammonia-market>
6. C. Kong Chyong, E. Italiani and N. Kazantzis, *Nature Communications* **2025**, 16, 766.

Acknowledgements

This activity is part of the AMAZE project. This research was funded by the CETPartnership, under the Joint Call 2023. The CETPartnership's research projects are co-funded by the European Commission (Grant Agreement No. 101069750) and the national funding organizations listed on the CETPartnership website.